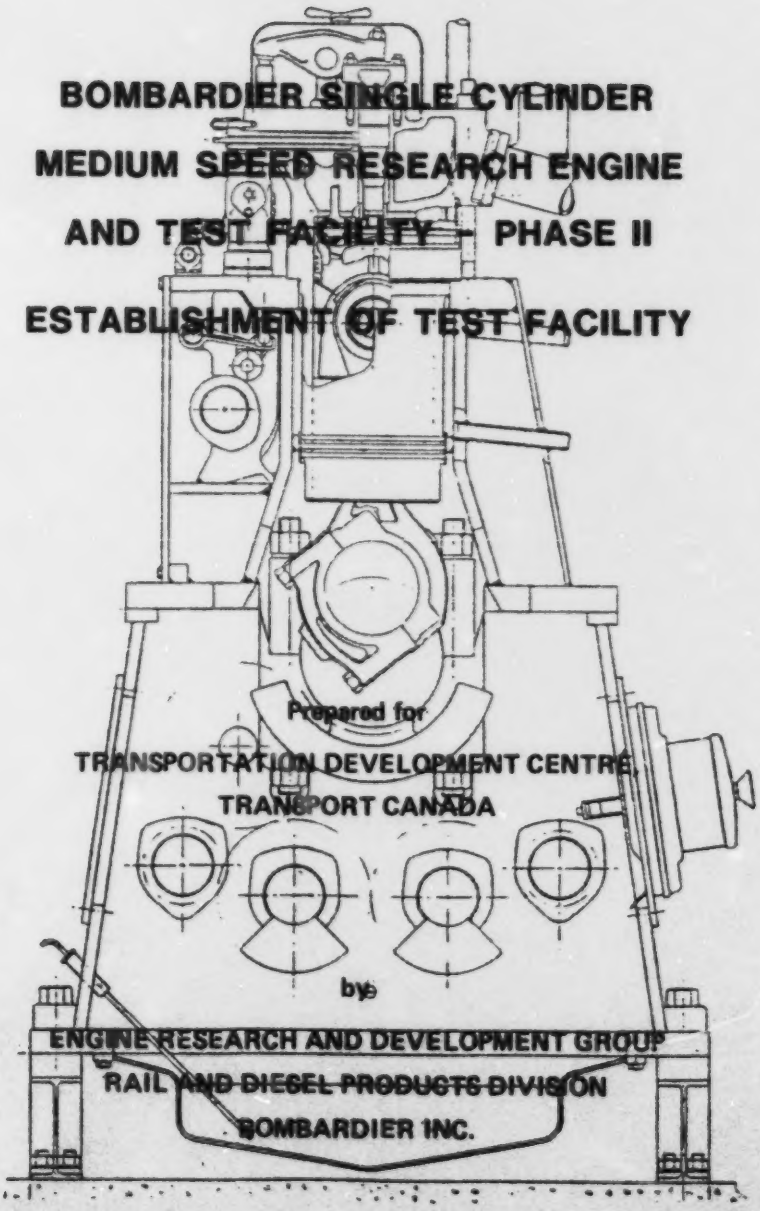
TP 6876E

BOMBARDIER SINGLE CYLINDER MEDIUM SPEED RESEARCH ENGINE AND TEST FACILITY - PHASE II

ESTABLISHMENT OF TEST FACILITY



Prepared for

TRANSPORTATION DEVELOPMENT CENTRE,
TRANSPORT CANADA

by

ENGINE RESEARCH AND DEVELOPMENT GROUP
RAIL AND DIESEL PRODUCTS DIVISION
BOMBARDIER INC.

July 1985

CA1
DTC 845
85
B57
c.2

TP 6876E

Library and Information Centre
Centre de Documentation (GSL)
RECEIVED – REÇU LE
DEC 5 1985
Government Publication Officielle
Transport Canada / Transports Canada

BOMBARDIER SINGLE CYLINDER MEDIUM SPEED RESEARCH ENGINE AND TEST FACILITY - PHASE II ESTABLISHMENT OF TEST FACILITY

BY

M.L. Payne
ENGINE RESEARCH AND DEVELOPMENT GROUP
RAIL AND DIESEL PRODUCTS DIVISION
BOMBARDIER INC.

JULY 1985

THE CONTENTS OF THIS REPORT REFLECT THE VIEWS OF THE CONTRACTOR AND NOT NECESSARILY THE OFFICIAL VIEWS OF THE TRANSPORTATION DEVELOPMENT CENTRE

PROJECT TEAM

The project team was composed of:

R.M. Dunton

M.L. Payne

S. Kandiah

REPORT DOCUMENTATION FORM

1. Transport Canada Report No.	2. TDC Project No.	3. Recipient's Catalogue No.
TP 6876E	4833	

4. Title and Subtitle	5. Report Date
Bombardier Single Cylinder Medium Speed Research Engine and Test Facility - Phase II: Establishment of Test Facility	July 1985
	6. Performing Organization Report No. 484200
7. Author(s) M.L. Payne	8. Transport Canada File No. D1465-372-2-2
9. Performing Organization Name and Address Bombardier Inc. Engine Research & Development Department Rail & Diesel Products Division 1505 Dickson, Montreal, Quebec H1N 2H7	10. DSS File No. 10SD T8200-2-2545
	11. DSS or Transport Canada Contract No. OSD83-00018
12. Sponsoring Agency Name and Address Transportation Development Centre (TDC) Guy Favreau Complex 200 Dorchester Blvd. W. Suite 601, West Tower Montreal, Que. H2Z 1X4	13. Type of Report and Period Covered
	14. Sponsoring Agency Code
15. Supplementary Notes	16. TDC Project Officer Roy S. Nishizaki

17. Abstract

The Bombardier Single Cylinder Research Programme was initiated in 1982 with the cosponsorship of the Transportation Development Centre of Transport Canada (TDC). The first phase of this programme covered the design of the engines and the test facility and the build of the engines, documented in "Design of a Single Cylinder Medium Speed Research Engine and Test Facility " (TP4844E), August 1983 and July 1985 (Addendum).

This report describes the work of the second phase, the objective of which was construction of the test facility and installation of the engines. Two test cells were constructed to accommodate the 1-251 and the 1-82400 engines. Foundations and supports were dependent on soil tests and predicted engine unbalance forces. Each engine is mounted on a seismic mass approximately five times that of the engine. Ease of maintenance, space optimization and accessibility were the main criteria taken into consideration in designing the modular layout of the equipment. Electrical, mechanical and control instrumentation systems are described.

18. Key Words	19. Distribution Statement
Single cylinder diesel research engine medium speed direct injection combustion test facility	Limited number of copies available from Transportation Development Centre

20. Security Classification (of this report)	21. Security Classification (of this page)	22. No. of Pages	23. Price
Unclassified	Unclassified	32	Nil

TDC/CDT 79-005

FORMULE DE DOCUMENTATION POUR RAPPORT

1. N° du rapport Transports Canada	2. N° de l'étude — CDT	3. N° de catalogue du destinataire
TP 6876 E	4833	

4. Titre et sous-titre	5. Date du rapport
Bombardier Single Cylinder Medium Speed Research Engine and Test Facility - Phase II: Establishment of Test Facility	juillet 1985
	6. N° du rapport de l'organisme exécutant: 484200

7. Auteur(s)	8. N° de dossier Transports Canada
M.L. Payne	D1465-372-2-2

9. Nom et adresse de l'organisme exécutant	10. N° de dossier — ASC
Bombardier Inc. Dépt. Recherche & Développement des Moteurs Division des produits ferroviaires et diesel 1505 Dickson, Montréal, Québec H1N 2H7	10SD T8200-2-2545
	11. N° de contrat — ASC ou Transports Canada: OSD83-00018

12. Nom et adresse de l'organisme parrain	13. Genre de rapport et période visée
Centre de développement des transports (CDT) 200 ouest, boul. Dorchester Suite 601, tour ouest Montréal , Québec H2Z 1X4	14. Code de l'organisme parrain

15. Remarques additionnelles	16. Agent de projet — CDT
	Roy S. Nishizaki

17. Résumé

Ce rapport concerne le programme de recherche lancé en 1982 par Bombardier Inc. sur les moteurs monocylindres, et co-parrainé par le Centre de développement des transports (CDT). La phase I de ce programme concernait l'étude et la réalisation des moteurs et l'étude de l'installation d'essais. Voir le rapport TP 4844E "Design of a Single Cylinder Medium Speed Research Engine and Test Facility" daté d'août 1983 et l'addenda daté de juillet 1985.

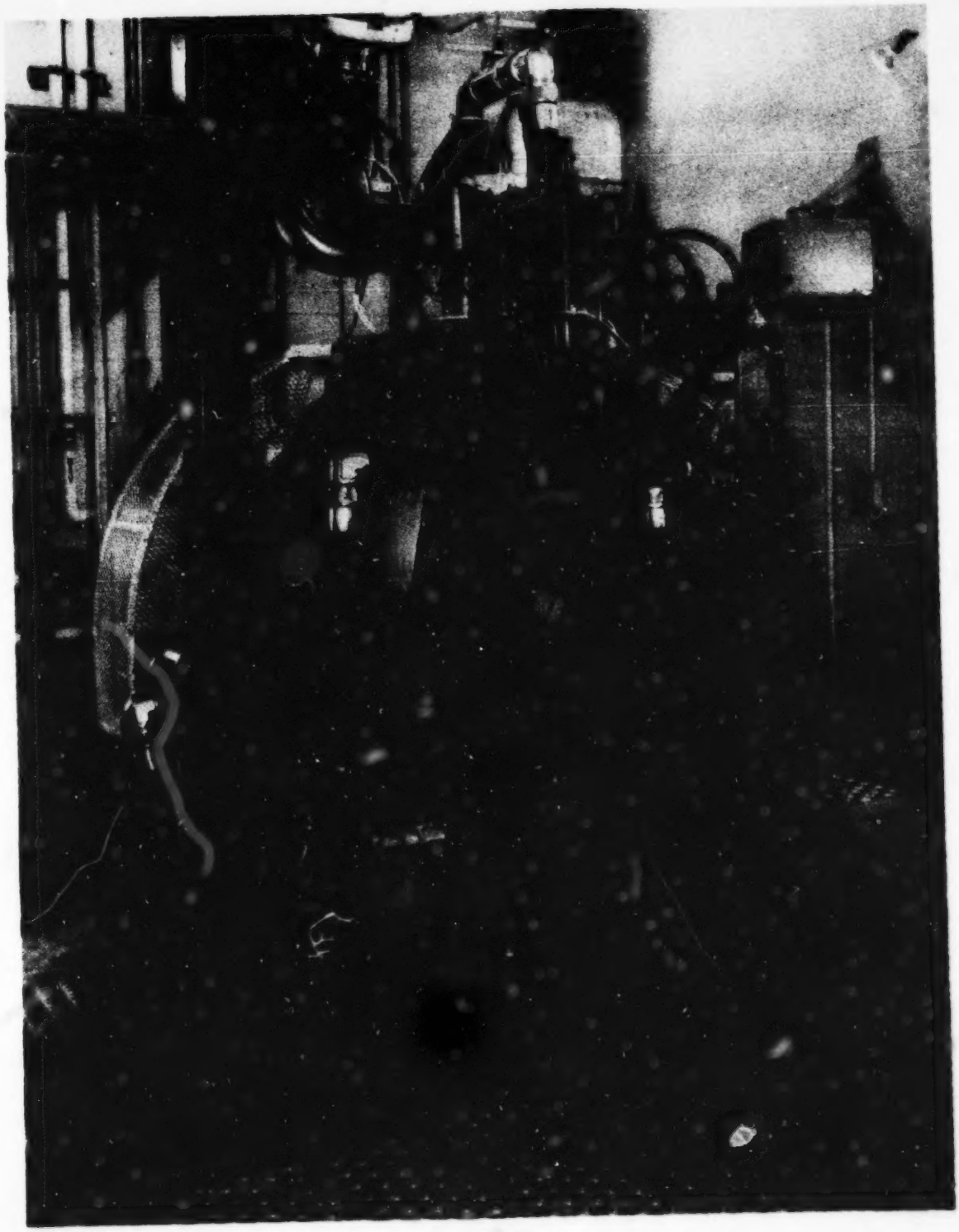
Dans le présent rapport sont décrits les travaux de la phase II dont l'objectif a été la construction de l'installation d'essais et la mise en place des moteurs.

Deux bancs d'essais ont été construits afin de recevoir les moteurs monocylindres 1-251 et 1-82400. Pour les fondations et les appuis, il a été tenu compte des essais de reconnaissance des sols et des forces de déséquilibre prévues à l'égard des moteurs. Chaque moteur était appuyé sur une masse inerte d'un poids environ cinq fois supérieur. Les principaux critères de l'étude de l'installation modulaire ont été la facilité de l'entretien, l'utilisation optimale des volumes et une bonne accessibilité. Les appareils de mesure et de contrôle électriques et mécaniques sont également décrits.

18. Mots-clés	19. Diffusion
Moteur de recherche diesel monocylindre, allumage, moteur semi-rapide, injection directe, installation d'essais.	Le CDT dispose d'un nombre limité d'exemplaires.

20. Classification de sécurité (de ce rapport)	21. Classification de sécurité (de cette page)	22. Nombre de pages	23. Prix
Non classifié	Non classifiée	32	Aucun

CDT/TDC 79-005



I-B2400
(BSCRE-001)

TABLE OF CONTENTS

SECTION		PAGE
1-	INTRODUCTION	1
2-	OVERVIEW OF BUILDING LAYOUT & CONSTRUCTION	2
3-	FACILITY MECHANICAL FEATURES	3
4-	AUXILIARY SYSTEMS	6
5-	CONTROLS AND INSTRUMENTATION	10

APPENDIX "A"

Figure 1	Air and exhaust chambers
Figure 2	Water, fuel, lube oil tanks and system control instrumentation
Figure 3	Control room and panel

APPENDIX "B"

Figure I	Airstart system schematic diagram
Figure II	Dynamoter system schematic diagram
Figure III	Fuel oil system schematic diagram
Figure IV	Cooling water system schematic diagram
Figure V	Jacket water system schematic diagram
Figure VI	Lube oil schematic diagram
Figure VII	Exhaust system schematic diagram
Figure VIII	Charge air system schematic diagram
Figure IX	Instrumentation system schematic diagram
Figure X	Instrumentation index list
Figure XI	Glossary of symbols
Figure XII	Engine foundation
Figure XIII	Building structure and plant location
Figure XIV	Typical equipment drawing

1- INTRODUCTION

The contents of this report deals with the establishment of the Bombardier Single Cylinder Research Engine (BSCRE) Test Facility.

Within the scope of the BSCRE Programme are phases which sequentially progress to a fully operational state-of-the-art facility, capable of satisfying the needs of Bombardier in the endeavour to produce reliable, adaptable medium speed diesel engines having the capacity to burn off-specification and alternate fuels with higher efficiencies in fuel consumption and emissions.

Phase I of the Programme covered the design of the engine and a typical test facility which could be adapted to suit local constraints. This work was documented in TDC report #4844E, DESIGN OF A SINGLE CYLINDER MEDIUM SPEED RESEARCH ENGINE AND TEST FACILITY, Dated August 1983.

The Engine R&D Test Center, at the present time, has two up-to-date multi-cylinder engine test cells which defined the location and the parameters which would have to achieve compatibility and system integration of the two new single cylinder test cells. This Phase II report describes the BSCRE test facility and the applied changes from the typical design that were incorporated into the test center.

2- BUILDING & CONSTRUCTION

Since the existing test facility could not house the two single cylinder engines, the decision was made to add an extension to the test center. The cost of this structure had to meet the previously Bombardier budgeted amount of $100,000.00. The chosen building configuration contained a floor area of approximately 785 sq ft. Divided into three rooms, two cells and a common utility room (see Fig. XIII Appendix "B"), this common room contains the control area for both cells & electrical motor control center (MCC). The walls are constructed of steel rod reinforced concrete block with glass fibre thermal insolation and aluminum siding on the exterior. Except for the engine foundation, the floor is of poured concrete. In order to dissipate the damaging vibratory forces which are inherent in single cylinder engines the engine foundation was designed to absorb the major portion of this energy. During the construction of the multi-cylinder test cells an analysis of the sub-strata was made and from this study it was concluded to support the foundation block on steel piles driven to bed rock. Isolation of the block from the building is achieve by a flexible membrane around and below the reinforced concrete clock on a bed of compacted sand (see Fig. XII Appendix "B"). Cast into the seismic foundation block are laterally adjustable anchor bolts for holding the engine and dynamometer skids in place.

The test cell is equipped with all the necessary services including an overhead crane. Allowance were made to accomodate future equipment or changes due to research study requirements such as openings in the roof for a cooling tower or radiator system and ventilation fans should the existing systems not be adequate. Also exterior fuel oil and drain connections are provided which will be connected to an exterior fuel supply when that system is installed.

The location of the test cells with respect to the existing storage and workshop areas eliminated the necessity of providing additional space to satisfy these funtions.

3- FACILITY MECHANICAL FEATURES

3.1 EQUIPMENT

The BSCRE Test Facility consists basically of two cells and a common control area. The layout of the equipment within each cell is a mirror image of the other.

In order to maximize the use of the available space, all auxiliary equipment except for air-start and dynamometer supply piping are located on one side of the cell. The intent was to free-up as much floor space as possible therefore a support structure and mounting system was devised which would allow the tanks and reservoirs to be located off the floor.

The auxiliairy systems supply piping, i.e. fuel, water, and air, enters the cell at the upper corner above the equipment rack then branches to each system. As shown in Appendix "A2" the three fluid supply tanks from right to left, are the jacket water holding 455 liters, fuel oil 455 liters and the lube oil with a capacity of 680 liters. Situated between the tanks are two heat exchangers which preheat the jacket water and lube oil as required. Adjacent to each system arrangement the manual circuit breakers and stop/start switches are located at the lower level of the equipment rack with manual normally open or closed valves, flow measuring devices and indicators. At the center of this lower apparatus cluster is a fuel measuring device. This fuel measuring device was designed and built by the Bombardier Engine Lab. based on and old and well known gravimetric method but incorporating today's microprocessor technology.

As can be seen the basic layout consists of three main equipment groupings, water, fuel, and lube oil terminating at floor level

with all related controls and instrumentation within these groups. This vertical arrangement facilitates circuit tracing, trouble shooting, and maintenance.

Outlets from the three systems are at floor level and are routed beneath the engine maintenance platform to the engine.

3.2 INTAKE AND EXHAUST

The apparatus which is required to simulate turbocharging is part of the intake charge air and exhaust systems. (see Appendix "A-1")

A remote compressor supplies a maximum of 1200 CFM of air which passes through a series of heaters to a plenum chamber containing more than forty times the cylinder volume thus smoothing the pulsations to an acceptable level. The capacity of the chamber is critical to the multi-cylinder representation. A flexible bellows connector joins the chamber to the inlet flange of the engine.

The exhaust system consists of an expansion chamber connected to the engine by a flexible bellows connector, a fixed orifice which simulates the characteristics of a turbocharger turbine, a variable gate valve, and finally an exhaust silencer. The variable valve controls the pressure setting which would be representative of the multi-cylinder engine manifold configuration. The location of both the air plenum chamber and the exhaust expansion chamber determines the tuned lengths of the system being simulated.

3.3 ENGINE AND DYNAMOMETER

In the middle of the cell is the skid mounted engine and dynamo-

meter, held in place by lateraly adjustable anchor bolts. The engine is connected to the hydraulic dynamometer which is capable of absorbing four hundred horsepower by a torsionally soft coupling. Situated around the assembly is a removable non-slip platform to facilitate engine maintenance.

3.4 SAFETY

For reasons of safety and the protection of working personel, a free standing guard covers the flywheel. Fusible links and deadman valves are incorporated in the fuel circuits which will stop fuel flow in case of fire. Also the cell floor is below level of the MCC/control room floor thus containing any fuel spillage.

4- AUXILIARY SYSTEMS

4.1 ENGINE JACKET WATER

Schematic drawing Fig. V in Appendix "B" shows the circuit for the engine water system. An electric motor driven water pump circulates water through the engine jacket and heat exchanger (tube side). The flow through the engine jacket is measured by an electro magnetic flow meter. Temperature of the engine jacket-water system is controlled to any desired set-point by a temperature control valve on the process cooling water side (shell side) of the heat exchanger.

The system header tank (expansion tank) maintains the system filled and vented during operation. This tank will also compensate for the expansion of the water during operation.

The system includes a pre-warmer (thermostatically controlled) in the recovery tank that heats and circulates the jacket water to aid cold starting. This recovery tank is also used for water treatment of the engine jacket water system.

To simulate water flow variation proportional to the engine speed in comparison with a multi-cylinder engine, a remote controlled throtting valve is installed on the engine jacket water system.

Temperature and pressure transmitters are installed as shown in the schematic drawings.

4.2 AIR START SYSTEM

The air start-system (Appendix "B" Fig. I) is connected to the main header used for starting engines. The air passes through

a shut-off valve into a pressure reducer that decreases the air to the nominal 150 psi working pressure of the start motor. Before reaching the start motor, the air passes through a filter and lubricator. The actuation of the starter is by a solenoid valve controlled by a start switch at the console.

4.3 AIR INTAKE AND EXHAUST SYSTEM

The air and exhaust system shown schematically in Appendix "B" Fig. VIII also includes part of the existing shop air and main supply line. The air passes through a shut-off valve into a pressure reducer (from 100 psi to 45 psi) which is remotely controlled from the console for desired testing pressure ratios. The air after the pressure reducer enters electric heaters which raises the temperature to preset points as required.

A surge tank and an expansion chamber are installed in the cell close to the engine. A restricting orifice and butterfly valve are installed in the exhaust ducting to simulate multi-cylinder exhaust pulsations and back-pressure. An exhaust silencer is located on the roof on the test cell.

4.3 LUBRICATING OIL SYSTEM

Fig.VI in Appendix "B" is a scheme of the lube oil system for circulating, filtering, and cooling the engine oil. An electric motor driven pump draws oil from the sump and passes it through a magnetic filter, heat exchanger, and filter then into the engine main bearings.

A thermostatic controlled oil-warmer is installed in the oil recovery tank, for heating the lube oil to aid in cold starting.

To simulate multi-cylinder engine oil flow variation proportional to the engine speed of an engine driven pump, a motorized valve with bypass pipework is installed on the engine lube oil system.

Temperature pressure and flow transmitters are installed as shown in the schematic drawing.

4.5 FUEL OIL SYSTEM

The fuel oil system shown schematically in Fig. III Appendix "B" does not include the main storage tank and supply pump.

Fuel is pumped to the day tank (4 hour supply) from the main storage tank. The level of the day tank is controlled by a level switch. Fuel flows by gravity into a small weighing tank within the fuel flow measuring device when the solenoid valve is energised by the fuel.

The fuel oil measuring device consists of a single channel microprocessor based process monitor (Visipak VIP524W) connected to a load cell which carries the weighing tank.

Fuel is drawn from the fuel weigher by the engine booster pump which then passes it through a filter to the engine fuel pump. This pump incorporates a pressure relief valve that returns excess fuel to the fuel weigher.

4.6 ENGINE/DYNAMOTER - LOAD AND SPEED CONTROL

The speed of the engine is controlled by an electronic engine governor, the set-point forwhich is adjusted by a servo motor. Details of the control system are covered under electrical system. The gover-

nor will adjust the fuel pump rack to suit the load on the engine and to maintain a constant engine speed.

The load on the engine is controlled and measured by the Schenk D1100 hydraulic dynamometer. The required load is maintained by controlling the amount of water in the casing which is determined by the position of the outlet valve. The load is measured by a strain-gauged cell fixed between the casing and dynamometer bed-plate.

5.0 SYSTEM CONTROL & INSTRUMENTATION (Ref. Appendix "B")

All auxiliary systems can be turned "ON/OFF" through "START/STOP" push button or "ON/OFF selector switches located at the "MAIN control panel". Auxiliary systems driven by an electrical motor can also be controlled through a local "START/STOP" push button. The local controls shall be used only under emergency conditions or during routine maintenance check. Under normal conditions the systems must be operated from the control panel. The status of each system is given through indicating lights located at the main control panel and the Motor Control Center. (MCC)

5.1 INDICATOR LIGHTS

Th lights located on the control panel and the indicated status are as follows:

"READY" to be started	-	Green flashing
"RUN"	-	Green steady
"ON HOLD" for auto start	-	Yellow steady
"CRITICAL ALARM"	-	Red flashing
"MAJOR ALARM"	-	Yellow flashing
"MINOR ALARM"	-	Blue flashing
"WARNING ALARM"	-	White flashing
"NORMAL CONDITION	-	White steady

An additional light located at the motor control center shows its status.

"OVERLOAD"	-	White steady

5.2 ENGINE CONTROL

Once started, the speed and the load of the diesel engine are

controlled through the two joy sticks located at the control console. The engine can only be started from the main control panel under normal operation, or from any of the local emergency stop buttons under emergency conditions. The engine will stop automatically in the occurence of any of the emergency conditions which are considered hazardous.

There is no provision at this time for automatic mode control of the diesel engine. The speed and the load as well as the governor status (ON/OFF) are controlled manually by the operator.

Before the engine can be started, a pre-start routine must be followed as described below:

5.2.1 Inside the test cell

a) Release the local emergency stop button of each of the auxiliary systems.
b) Close the isolating switch of each of the auxiliary systems.
c) Release the two local emergency stop buttons of the diesel engine.

5.2.2 At programmable controller "CP-67-01"

a) Turn the "processor" key to the "run" position.
b) Make sure that the "interface" key is in the "Monitor" position.

5.2.3 At the Motor Control Center "MCC-67-01"

a) Check if all required overload relays are set.
b) Close the breaker of each "starter", "contactor" or "feeder unit"
c) Close circuit breakers at instrumentation panel board.

5.2.4 At main control panel

a) Check that all instrument power supplies are plugged in.
b) Release the two emergency stop buttons of the diesel engine.
c) Turn the selector switch "Console power" to the position "ON". The indicating light "Console power on" will come on.
d) Push the "test" push button to verify the working condition of all panel indicating lights and audible alarm devices.
e) Place "joy sticks" for control of the speed and load of the engine at the "low position".
f) Turn the selector switch "elapsed time" to the position "ON". The indicating light "elapsed timer on" will come on.
g) Disable the initial "Emergency stop condition". Flashing green lights shall come on indicating readiness of system.

5.3 AUXILIARY SYSTEMS AUTOMATIC CONTROLS

Pre-programed into the controller are a series of conditions which must be met prior to any of the auxiliary systems being energized. When the pre-conditions, as listed below, are satisfied, depressing the start button on the main panel or in

the test cell will initiate engine start-up. Typical pre-conditions are:

- Incoming breaker of MCC closed.
- Compressor contactor breaker closed.
- Overload relays at local starters reset.
- Local emergency stop push button released.
- Selector switch "Console power" turned to the "ON" position.
- Indicating light "TRIP" (White) OFF
- Indicating light "STOP" (Red) ON
- Indicating light "RUN" (Green) OFF/FLASHING
- Indicating light "HOLD" (Yellow) OFF
- Jacket water pump & heater breaker closed
- Fuel pump & heater breaker closed
- Local isolation switch closed
- Air start switch closed
- Test cell air inlet & outlet fan
- Dyno control switch closed.

5.3.1 Air compressors

The diesel engine starting air system is common to all test cells. The system is controlled from Test Cell 1, but indication of the system status, "Request to start". "RUN" or "On hold" was installed on the "Main control panel" of cell 4 and cell 5.

Start

If the air pressure (PSL-124) inside the air tanks is below the normal required value, to turn the diesel engine during start-up, the green light shall be flashing indicating "requirement to be started".

Depress any of the "start" push buttons, if the air pressure is low the compressor will start and the green light will come on steady, indicating "run". If the air pressure is

normal, the compressor will remain stopped and the yellow light indicating "Normal air pressure, automatic start engaged", will come on.

Stop

Depress the "Stop" push button located on the control panel or in case of emergency the local cell "STOP". The red light indicating "Stop" will come on steady or flashing and if the air pressure is low the green light will flash.

Abnormal Conditions

a) White light flashing, red steady and audible alarm at the control panel:
   - Indication of "Starter overload"

b) White and red lights steady:
   - Indication of "Contactor breaker open"

c) Red light flashing and audible alarm at the control panel:
   - Indication of operation of the local stop push button.

Interlocks with other systems

Automatic start and stop of the compressors by the pressure switch PSL-124 at the air tanks.

5.3.2 Fuel oil supply pump

Similarly to the air system, the fuel oil supply system is common to all test cells. It is also controlled from test cell 1, and indication of the system status, "Request to start",

"Run" or "On Hold" is installed on the control panel of all cells.

Start

If the level (LSH/L-524 for test cells 4 and 5) at any of the "Fuel day tanks" (one at each test cell) is below, the normal operating value, the green light will be flashing . Depress any of the "Start" push buttons, the fuel pump motor will start and the green light will come on steady indicating "Run". If all the levels are normal, the motor will remain stopped and the yellow light indicating "All levels normal, automatic start engaged", will come on.

Stop

Depress the "Stop" push button located at the test cell 1 control panel or in case of emergency the local "Stop". The red light indicating "Stop" will come on steady or flashing and if any of the control levels is low the green light will flash. The pump will also stop and the automatic start disengaged in the occurrence of an extra low level (SLL-100) in the main fuel tank.

Abnormal conditions

a) White light flashing, red steady and audible alarm at control panel:
   - Indication of "starter overload"

b) White and red lights steady:
   - Indication of "starter breaker open"

c) Red light flashing and audible alarm at control panel:
   - Indication of operation of the local stop push button.

5.3.3 Fuel Oil Booster Pump

Start

If the pre-conditions are satisfied (green light flashing) depress any of the "Start" push buttons, the fuel oil booster pump motor will start and the green light will come on steady indicating "Run".

Stop

Depress the "Stop" push button located at the test cell control panel or in the case of emergency the local one. The fuel oil booster pump will also stop automatically in the occurrence of an emergency stop condition of the diesel engine (ESD).

Abnormal Conditions

a) White light at the starter door steady on:
   - Indication of "Starter overload"

b) Green light at the control panel off:
   - Indication of "Not all pre-conditions satisfied"

c) Green light continues flashing and motor doesn't start when button is depressed indication one or more of the following:
   - Faulty control circuit fuse.
   - Starter breaker open.
   - Overloads not reset.
   - Faulty AC output card fuse.
   - Local stop push button released.

d) Green light steady on but motor doesn't run:
   - Indication of local isolating switch open.

Interlock with other systems

The fuel oil booster pump doesn't run if an emergency stop condition of the diesel engine exists.

5.3.4 Fuel Oil Valve

Operation

Once the pre-conditions are satisfied the solenoid will be automatically controlled by the fuel oil day tank level(LSH/L-524). This same signal is also used to control the fuel oil supply pump (65-01-13). In the occurrence of a low level in the day tank the solenoid will be energized and the fuel valve opened. When the fuel reaches the normal operating level, the solenoid will be de-energized and the valve will close. If during a re-filling process an "ESD" condition occurs, the valve will close automatically. In the event that a defect in the normal high level switch prevents the valve from closing, the tank will continue to refill until the extra high level switch actuates and the valve closes.

5.3.5 Fuel oil measurement system

Operation

Once the pre-conditions are satisfied, the system is automatically controlled through the fuel weight high/low switches (WSL/WSH-522). When the fuel measurement tank is empty (WSL-522 open), the solenoid valves WV-522A/B will energize and the fuel line will open. During and for the 60 seconds following the refilling of the measurement tank a yellow light indicating "False reading" will come on flashing. The fuel line will close once the refilling operation is complete (WSH-522 open). The system is disabled when the selector switch HC-522 is turned to the "OFF" position. The low weight switch can be bypassed by the selector switch HC-522 when turned to the position "OPEN". This position is not self-maintained, but has a

spring return to the center mechanism. This over ride mode allows the operator to refill the measurement tank without the requirement of a low fuel weight.

5.3.6 Cooling water valves

Operation

The cooling water system is controlled from the main control panel through the selector switch HC-582. The solenoids will be energized and the valves "Open" with the selector switch on position "Run"

5.3.7 Jacket water valve

Operation

The jacket water valve is controlled from the main control panel through the selector switch HC-566.

With the selector switch in the "OPEN" position the motorized valve actuator will operate to open the valve, The opening action can be interrupted at any desired position of the actuator. When the fully open position is reached, the opening action will automatically be interrupted. With the selector switch in the "Close" position the valve will close, the closing action will also be automatically interrupted when the fully closed position is reached.

The selector switch HC-566 has a spring return to the center mechanism from both the "OPEN" and "CLOSE" positions.

5.3.8 Jacket Water Pump

If the pre-conditions are satisfied (green light flashing) depress any of the "START" push buttons. The jacket water pump motor will start and the green light will come on steady indicating "RUN".

Stop

Depress the "STOP" push button located at the test cell main control panel or in case of emergency the local one. The jacket water pump will also stop automatically in the occurrence of an emergency stop condition of the diesel engine (ESD). If the pre-conditions are not all satisfied, the green light will be OFF.

Abnormal conditions

a) White light at the starter door steady on:
   - Indication of "Starter overload".

b) Green light at the main control panel off:
   - Indication of "Not all pre-conditions satisfied".

c) Green light continues flashing and motor doesn't start after start button is depressed is indication of one or more of the following:
   - Faulty AC output card fuse.
   - Faulty control circuit fuse.
   - Starter breaker open.
   - Local stop push button not released.
   - Overload not reset.

d) Green light steady on but motor doesn't run:
   - Indication of local isolating switch.

Interlock with other systems

The jacket water pump will not run if an emergency stop condition of the diesel engine exists.

5.3.9 Jacket water heater

Start

If the pre-conditions are satisfied, (green light flashing) set the timer on the control panel with the delay that will have to elapse from the instant the system is started until the moment the heating process has to start and depress the "START" push button at the main control panel. If the pre-set time has elapsed and if the water temperature is low (TSH-J*105 closed), the jacket water heater will start and the green light will come on steady indicating "RUN". If the pre-set time has not elapsed or if the water temperature is normal (TSH-J* 105 open), the jacket water heater will remain on "HOLD": the green light will go "OFF" and the yellow light will come "ON" steady indicating "Normal temperature, automatic start engaged" or flashing indicating "On delay timer running, automatic start engaged".

Once the automatic start is engaged and the "on delay" time elapsed the heater will be controlled by the temperature switch. When the water is transferred from the tank to the diesel engine jacket system the level switch LSL-569 will open and the automatic start will be disengaged.

Stop

Depress the "Stop" push button located at the test cell main control panel. The jacket water heater will also turn off automatically in the occurrence of an emergency stop condition of the diesel engine (ESD), or if the water is transferred from the tank to the engine jacket. If the pre-conditions are not all satisfied, the "Green and Yellow" lights will be off.

Abnormal conditions

a) Green light at the main control panel off:
   - Indication of "Not all-preconditions satisfied".

b) Green and yellow lights "Off" and heater doesn't go on after start button is depressed is indication of one or more of the following:
   - Faulty AC output card fuse.
   - Faulty control circuit fuse.
   - Starter breaker open.

c) Green light steady on but heater doesn't go on:
   - Indication of local isolating switch open.

5.3.10 Lub oil pump

Start

If the pre-conditions are satisfied (Green light flashing), depress any of the "Start" push buttons, the lube oil pump motor will start and the green light will come on steady indicating "RUN".

Stop

The lubeoil pump panel mounted "STOP" push button is disabled while the diesel engine is running. Depress the "STOP" push button located at the test cell main control panel or in case of emergency the local one. The lube oil pump will also stop automatically in the occurrence of an emergency stop condition of the diesel engine (ESD). If the pre-conditions are not all satisfied, the green light will be off.

Abnormal conditions

a) White light at the starter door steady on:
   - Indication of "Starter overload".

b) Green light at the main control panel off:
   - Indication of "Not all-preconditions satisfied.

c) Green light constantly flashing and motor does not start after start button is depressed is indication of one or more of the following:
   - Faulty AC output card fuse.
   - Faulty control circuit fuse.
   - Starter breaker open.
   - Overloads not reset.
   - Local stop push button not released.

d) Green light steady on but motor does not run:
   - Indication of local isolating switch open.

Interlock with other systems

The lube oil pump does not run if an emergency stop condition of the diesel engine exists.

5.3.11 Lube oilheater

Start

If the pre-conditions are satisfied (green light flashing), set the timer on the control panel with the delay that will have to elapse from the instant the system is started until the moment the heating process has to start, then depress the "START" push button at the main control panel. If the preset time has elapsed and if the lube oil temperature is low (TSH-L *105 closed) the lube oil heater will automatically start and

the green light will be steady, indicating "RUN". If the preset time has not elapsed or if the lubeoil temperature is normal the lubeoil heater will remain on "HOLD"; the green light will go "OFF", and the yellow light will come "ON" steady indicating "Normal temperature, automatic start engaged" or flashing indicating "on delay timer running, automatic start engaged".

Once the automatic start is engaged and the "ON" delay time has elapsed, the heater will be controlled by the temperature switch. When the lube oil is transferred from the tank to the oil sump, the level switch will open and the automatic start will be disengaged.

Stop

Depress the "STOP" button located at the test cell main control panel. The lube oil heater will also turn off automatically in the occurrence of an emercency stop of the engine (ESD)or if the lube oil is transferred from the tank to the engine lube oil sump.

If the pre-conditions are not all satisfied, the green and yellow lights will be off.

Abnormal conditions

a) Green light at the main control panel off:
   - Indication of "Not all pre-conditions satisfied"

b) Green and yellow lights "off" and heater does not go on after start button is depressed is indication of one or more of the following:
   - Faulty AC output fuse.
   - Faulty control circuit fuse.
   - Starter breaker open.

c) Green light steady on but heater does not go on:

- Indication of local isolating switch open.

Interlock with other systems

The lube oil heater does not go on if one or more of the following conditions exist:

- An emergency stop condition of the diesel engine.
- The lube oil level in the tank is low.
- The preset "ON" delay time has not elapsed.

However, once started, the system is automatically controlled by the temperature switch until the tank is drained.

5.3.12 Lube oil valve

Operation

The lube oil valve is controlled from the main control panel through the selector switch HC-588.

With the selector switch on the "OPEN" position, the motorized valve actuator will operate to open the valve. The opening action can be interrupted at any desired position of the actuator. When the fully open position is reached, the opening action will be automatically interrupted. With the selector switch in the "CLOSE" position, the valve will close, the closing action will also be automatically interrupted when the fully closed position is reached.

The selector switch HC-588 has a spring return to the center mechanism from both the "OPEN" and "CLOSE" positions.

Engine air to air valve

Operation

The engine air to air heater solenoid will be energized to open the valve as soon as the governor "ON" push button is depressed. The solenoid will be de-energized and the valve will close on the occurence of any emergency condition.

Engine air to atmosphere valve

Operation

This solenoid is normally open and will be energized closing the valve when the engine is running. In the occurrence of an emergency condition the solenoid will de-energize, and the valve will open, releasing the trapped air to the atmosphere.

5.3.13 Engine air heater

Start

Depress the "Start" button at the main control panel. If there is no air flow through the air heaters the green light will go "OFF" and the yellow light will come "ON" steady indicating "No air flow, automatic start engaged". The air temperature is controlled automatically through an "SCR type resistive load controller" which receives a reference signal (4-20MA) from a temperature indicator controller.

As soon as there is air flowing through the heaters, the engine air heater will start, the green light will come on steady indicating "RUN" and the yellow light will go "OFF". If any of the heating elements overheat, the heater will be turned off, the green light will go "OFF", and the red light indicating "Overheat" will come on steady. This overheat protection

device has to be reset so that the heaters are able to restart.

Stop

Depress the "STOP" push button located at the test cell main control panel.

The engine air heater will also turn off automatically in the occurrence of an emergency stop condition of the engine, or in the loss of air flow or if any of the elements overheat.

If the pre-conditions are not all satisfied the green and yellow lights will be off.

Abnormal conditions

a) Green light at the main control panel off:
   - Indication of "Not all pre-conditions satisfied"

b) Green, yellow and red lights "OFF" and heater does not go on after start button is depressed is indication of:
   - Faulty AC output card fuse.
   - Faulty control circuit fuse.

c) Green light steady on but heater does not go on:
   - Indication of local isolating switch open.

Interlock with other systems

The engine air heater does not go on if:

- An emergency stop condition of the diesel engine exists.
- There is no air flow.
- The overheating protection of the elements are not reset.

Once started, the system is automatically controlled by the temperature indicator controller TIC-622 which sends a reference signal to the resistive load SCR controller.

5.3.14 Air inlet fan

Start

Provided the conditions are satisfied, (green light flashing), depress any of the "START" buttons. If the cell temperature is below the preset value indicated by the thermostat the damper is closed, the green light will go "OFF" and the yellow light will come "ON" steady indicating "Normal temperature, automatic start engaged". As soon as the cell temperature rises above the preset value, the air inlet motor will start automatically, and the green light will come on steady indicating "RUN". The yellow light will go off.

Stop

Depress the "STOP" push button located at the test cell main control panel or in case of emergency the local one. The air inlet fan will also stop automatically in the occurrence of an emergency stop condition of the engine.

Abnormal conditions

a) White light at the starter door steady on:
   - Indication of "starter overload".

b) Green light at the main control panel off:
   - Indication of "Not all pre-conditions satisfied" (check local stop button).

c) Green and yellow lights "OFF" and motor does not start after start button is depressed is indication of one or more of the following:
   - Faulty AC output fuse.
   - Faulty control circuit fuse.
   - Starter breaker open.
   - Overload not reset.

d) Green light steady on but motor does not run:
   - Indication of local isolating switch open.

Interlock with other systems

The "air inlet fan" does not run if an emergency stop condition of the diesel engine exists.

Once started, the system is automatically controlled by the cell temperature thermostat through damper position switch ZS-IF*125.

5.3.15 Air outlet fan

Start

Depress any of the "START" push buttons. If the cell temperature is below the preset value indicated by the thermostat the damper is closed, the green light will go "OFF" and the yellow light will come "ON" steady indicating "Normal temperature, automatic start engaged". As soon as the cell temperature rises above the preset value, the air inlet fan motor will start automatically and the green light will come on steady indicating "RUN". The yellow light will go off.

Stop

Depress the "STOP" push button located at the test cell main control panel or in case of emergency the local one. The air inlet fan will also stop automatically in the occurrence of an emergency stop condition of the engine.

Abnormal conditions

a) White light at the starter door steady on:
   - Indication of "Starter overload".

b) Green light at the main control panel off:
   - Indication of "Not all pre-conditions satisfied". (check local stop button)

c) Green and yellow lights "OFF" and motor does not start after start button is depressed is indication of one or more of the following:
   - Faulty AC output card fuse.
   - Faulty control circuit fuse.
   - Starter breaker open.
   - Overload not reset.

d) Green light steady on but motor does not run:
   - Indication of local isolating switch open.

Interlock with other systems

The "Air inlet fan" does not run if an emergency stop conditiom of the diesel engine exists.

Once started the system is automatically controlled by the cell temperature thermostat through damper position switch ZS-ÓF*125.

5.3.16 Dyno control unit

Start

Depress the start push button at the main control panel, the dyno control unit contactor will close and the green light will come on steady indicating "RUN".

Depress also the push button "Power on" on the face of the dyno control unit at the main control panel, a red indicating light will come on indicating "Power on".

Stop

Depress the "STOP" push button located at the test cell main control panel. The dyno unit will also turn off automatically in the occurence of an emergency stop condition of the engine.

Abnormal conditions

a) Green light at the main control panel off:
   - Indication of "Not all pre-conditions satisfied".

b) Green light continues to flash and dyno control unit does not go on after start button is depressed is indication of one or more of the following:
   - Faulty control circuit fuse.
   - Faulty output card fuse.
   - Dyno control unit contactor breaker open.

c) Green light steady on but heater does not go on:
   - Indication of open feeder.
   - or dyno control unit local push button "Power on" not depressed.

5.3.17 Governor

Governor "ON"

Depress the "Governor on" button located at the main control panel. If the pre-conditions are all satisfied, the electronic governor interface relay will be energized and the governor signal will go through. The green light will come on indicating "Governor on". For a period of five (5) seconds, following this, an audible signal in the test cell will indicates that the diesel engine is about to be started.

Governor "OFF"

Depress any of the four (two in the test cell and two in the main control panel) emergency stop push buttons. The power supply to the governor will also be switched off automatically in the occurrence of an emergency stop condition of the engine.

5.3.18 Air starter

Air starter "ON"

Depress and maintain the air starter "ON" push button, the solenoid HV-641 will energize and the starting air will turn the air starter and consequently the diesel engine until ignition is obtained. The green light indicating air starter on will be on. If ignition is not obtained in the next twenty (20) seconds following the beginning of the starting process, the starting circuit will be automatically disabled for a resting period of ten (10) seconds. Once there is ignition and the engine turns at a speed above 375 rpm the white indicating light "Engine run" will come on steady and the air starter will be disabled.

Air starter "OFF"

Release the air starter "ON" push button. The air starter solenoid valve HV-641 will also be automatically switched off.

6.0 ALARMS

Emergency shut down (ESD)

The following alarms are monitored by a special alarm unit, if any of the alarm conditions occur all systems will be shut down initiating a continuous audible signal.

- PSHL-520, Engine inlet fuel oil pressure.
- PSHL-565, Engine outlet jacket water pressure.
- TSHL-580, Engine inlet lube oil temperature.
- PSHL-581, Engine inlet lube oil pressure.
- TSHL-601, Engine exhaust air temperature.

- TSHL-661, Test cell air temperature.
- SSHL-664, Engine speed.
- WSHL-664, Engine load.
- TSHL-665, Engine cylinder head temperature.
- TSHL-666, Engine cylinder liner temperature.

The philosophy for the annunciation of this alarm will be determined and programmed into the alarm unit by the engine test engineer.

Warning

The following are alarms whose occurrence is not critical for the operation of the test cell since no material damage can result as a consequence of it's occurrence Nevertheless the action of the operator to correct the situation is required and ultimately is the operator's decision whether to shutdown the system.

LSHH-524/LSLL-524 - Fuel oil day tank level extra high/extra low.
LSH-545 - Dyno outlet cooling water temperature high.
TSH-564 - Jacket water temperature high.
LSL-562 - Expansion tank level low.
SSL-664-2/WSL-664 - Speed and load joy sticks not at low position.

The philosophy is that if any of the alarms occur, it will be memorized and indicated through a flashing light and an intermittent audible signal. As soon as the operator depresses the "Silence/Reset" push button, the audible signal will stop and the light will stay on steady if the alarm condition still exists or it will go off if the situation is corrected.

The main fuel oil tank level extra low LSLL-100 is also indicated on the main control panels of the cell.

APPENDIX "A"

BOMBARDIER SINGLE CYLINDER MEDIUM SPEED RESEARCH ENGINE AND TEST FACILITY - PHASE II ESTABLISHMENT OF TEST FACILITY

PHOTOS

Figure 1 Air/exhaust chambers

Figure 2 Water, fuel, lube oil tanks and system control instrumentation

Figure 3 Control room and panel

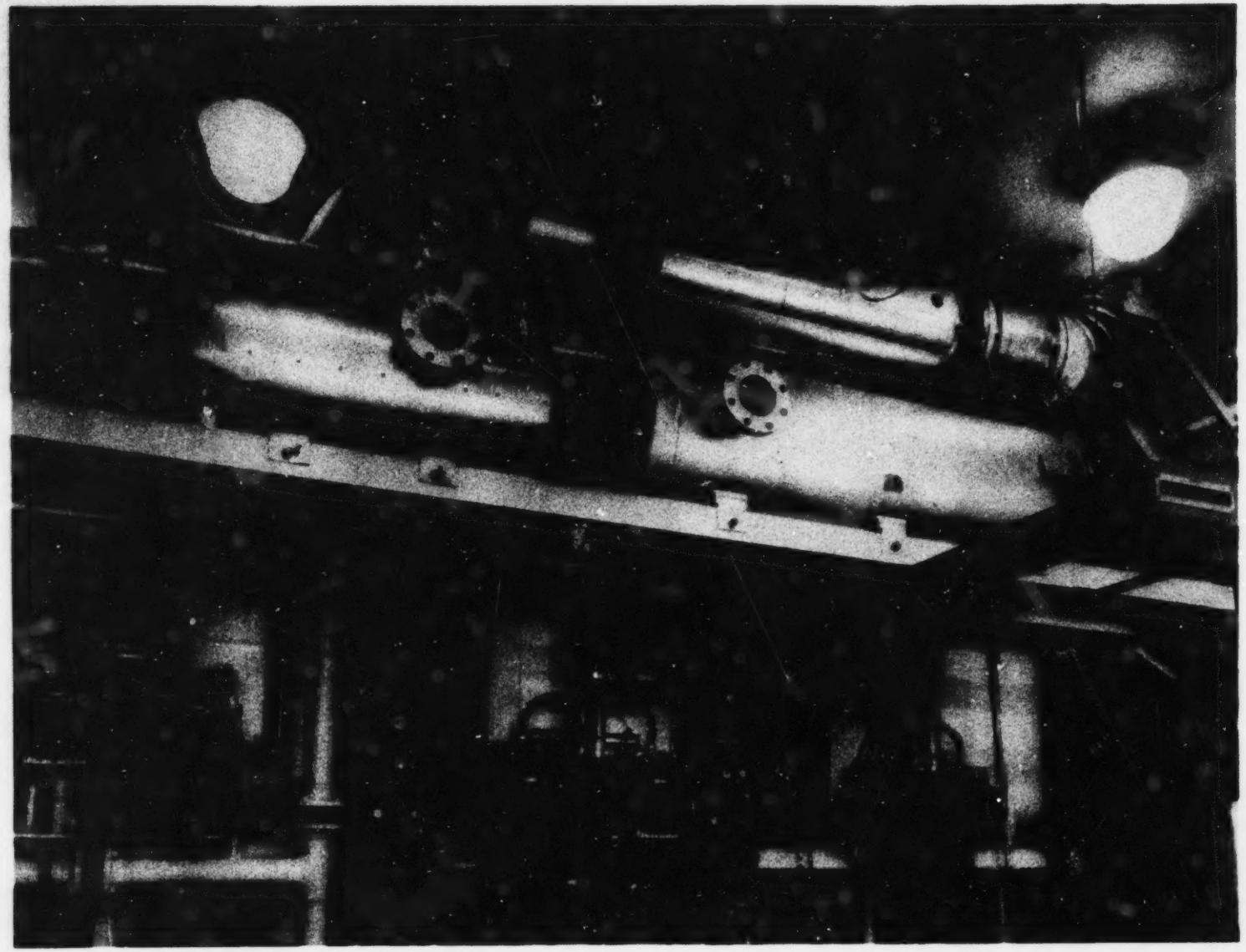


FIGURE 1 – AIR AND EXHAUST CHAMBERS

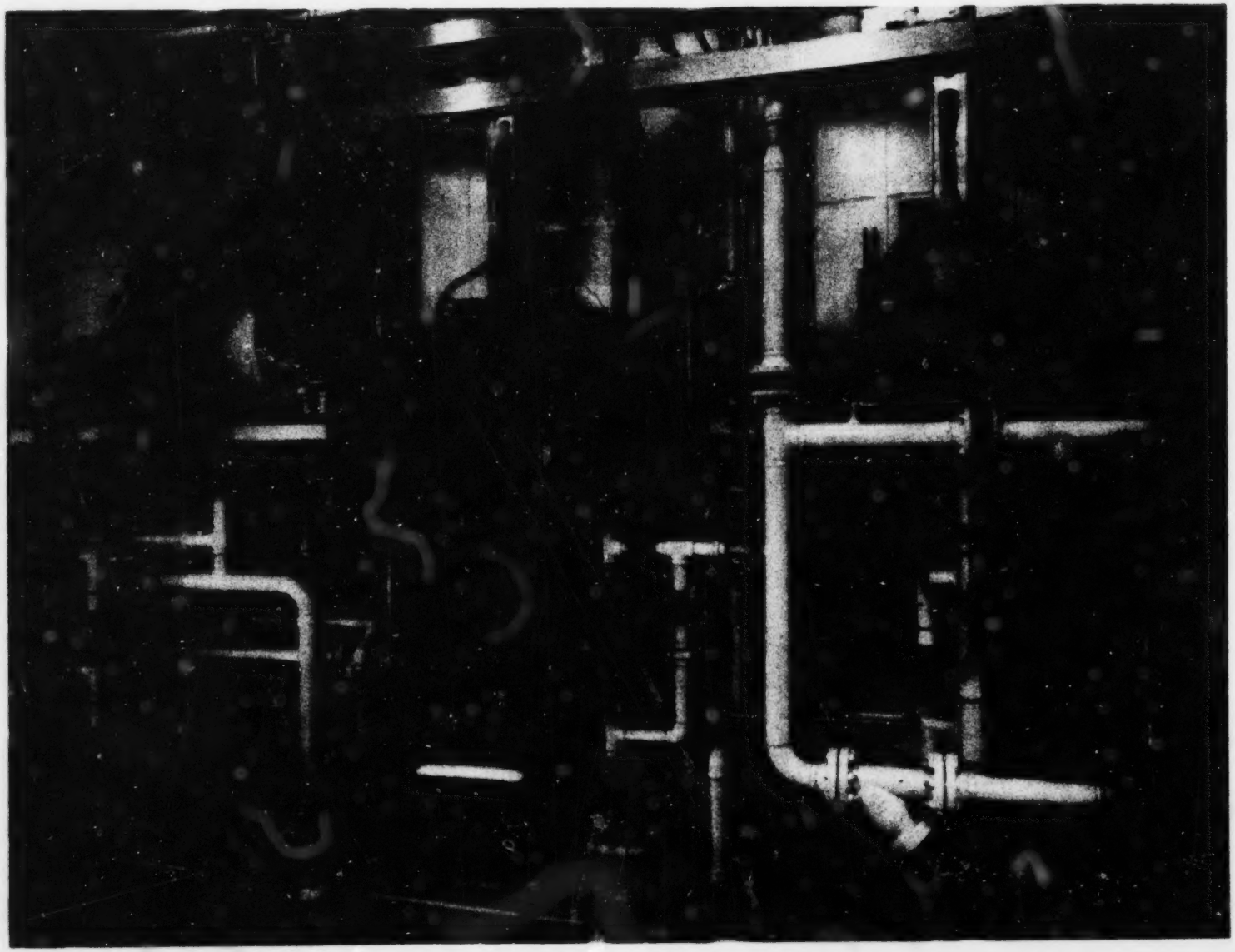


FIGURE 2 – WATER, FUEL, LUBE OIL TANKS AND SYSTEM CONTROL INSTRUMENTATION

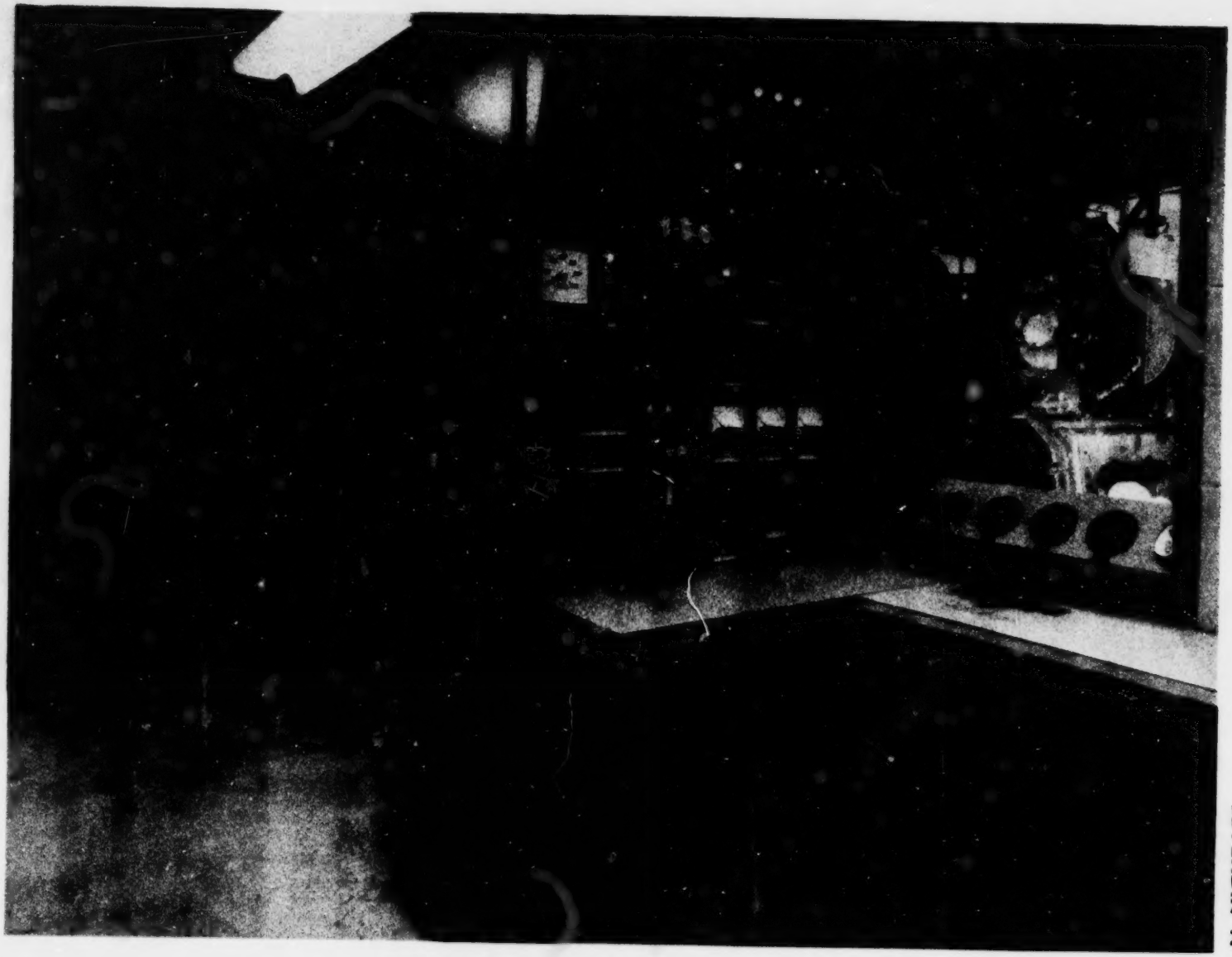


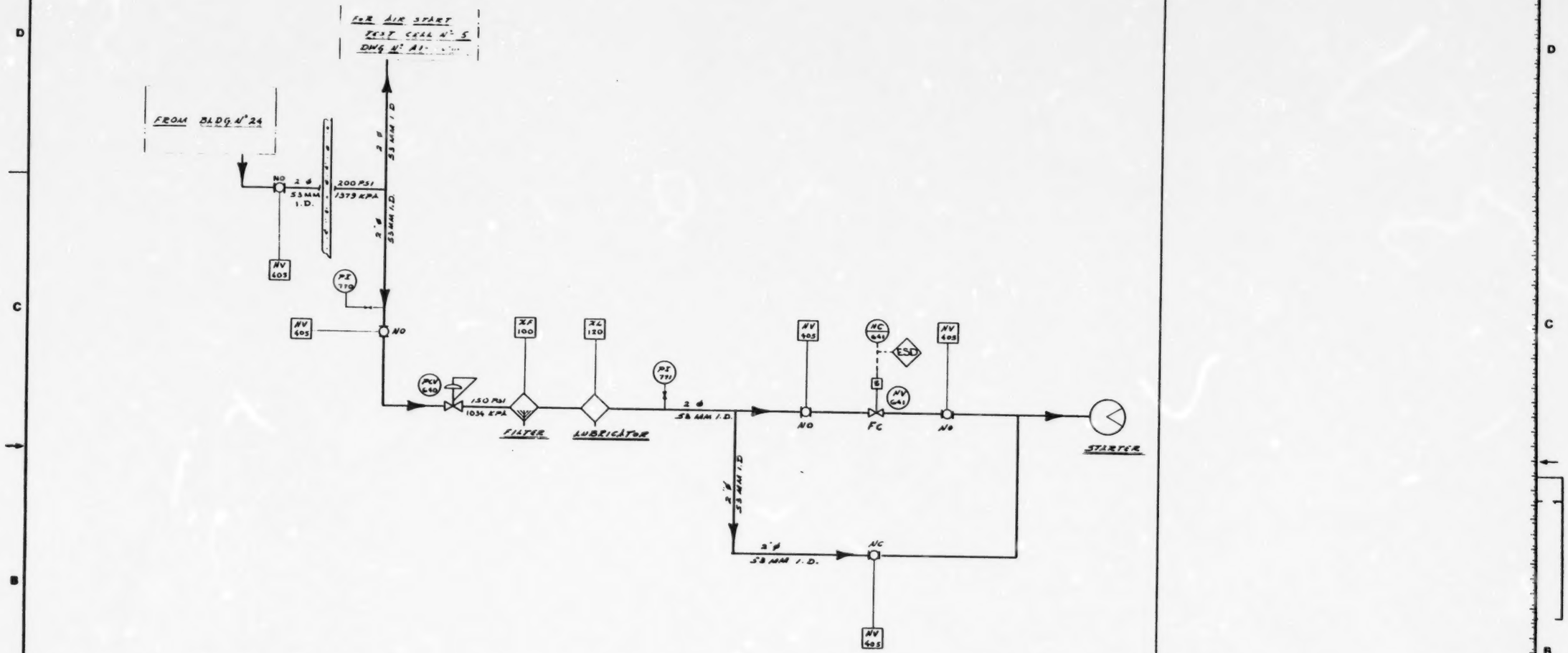
FIGURE 3 – CONTROL ROOM AND PANEL

APPENDIX "B"

BOMBARDIER SINGLE CYLINDER
MEDIUM SPEED RESEARCH ENGINE
TEST FACILITY

SCHEMATIC & DRAWINGS

Fig. I	Airstart system schematic diagram
Fig. II	Dyno system schematic diagram
Fig. III	Fuel oil system schematic diagram
Fig. IV	Cooling water system schematic diagram
Fig. V	Jacket water system schematic diagram
Fig. VI	Lube oil system schematic diagram
Fig. VII	Exhaust system schematic diagram
Fig. VIII	Charge air system schematic diagram
Fig. IX	Instrumentation system schematic diagram
Fig. X	Instrumentation index list
Fig. XI	Glossary of symbols
Fig. XII	Engine foundation
Fig. XIII	Building structure and plant location
Fig. XIV	Typical equipment drawing



Rév	Zone	Description	Insp'd
A		GENERAL REV	RA
B		GENERAL REV	RA
C		GENERAL REVISION	LM
D		ISSUED FOR QUOTATION	RA

Dessinateur: REAL L
Date: 83-09-22
Vérificateur: L.H
Date: 83 12 12
Ch. projet: S.V
Date: 83-12-12
Document:
Date:

PROJECTION

TOLÉRANCE ET FINI DE SURFACE SAUF INDICATION CONTRAIRE

MÉTRIQUE	.000	± .05
	.0000	± .025
	.00000	± .0025
IMPÉRIAL	0 30'	10'
FRAC (BASE)	± 1/32	± 1/64
DÉCIMAL	± .005	± .010
FRAC (BRUT)	± 1/16	± 1/8

ANGLES ±1/2° CHANFREINS 2°
ÉBARBER 1/64" / 0.4mm MAX
FINI DE SURFACE 125 micro - VV

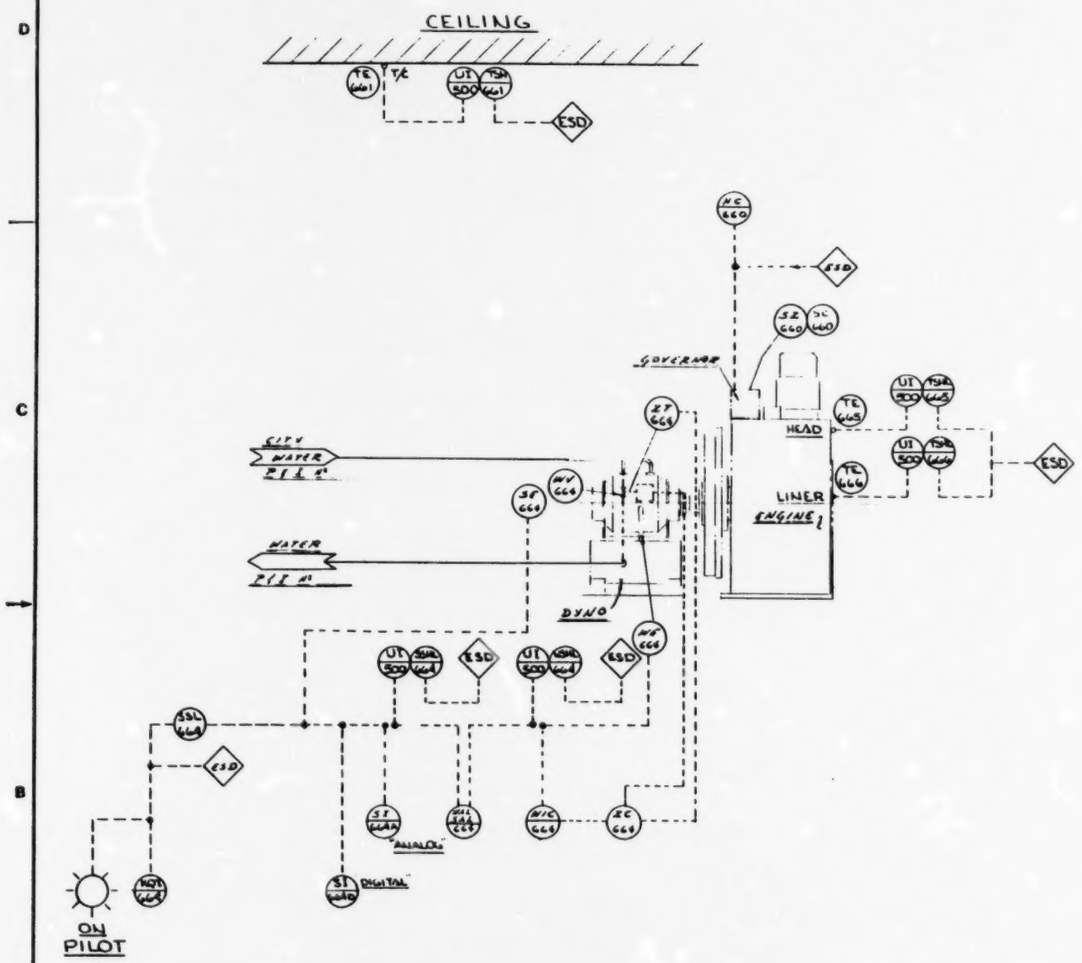
Ce plan ne doit être reproduit ni copié sans l'autorisation de Bombardier Inc.
This drawing may not be reproduced nor copied without the consent of Bombardier Inc.
N° référence
N° ensemble Assembly No
N° modèle
N° commande Sales Order No
A1
Échelle
1/1

Bombardier Inc.
Division des produits ferroviaires et diesel
Rail and Diesel Products Division
Montreal Quebec Canada

Titre (Objet)
AIR START SYSTEM
SINGLE CYL. ENG MODEL
TEST CELL

Feuille 1
N° Dessin Drawing No: A1-8800
Révision: D

FIG. 1

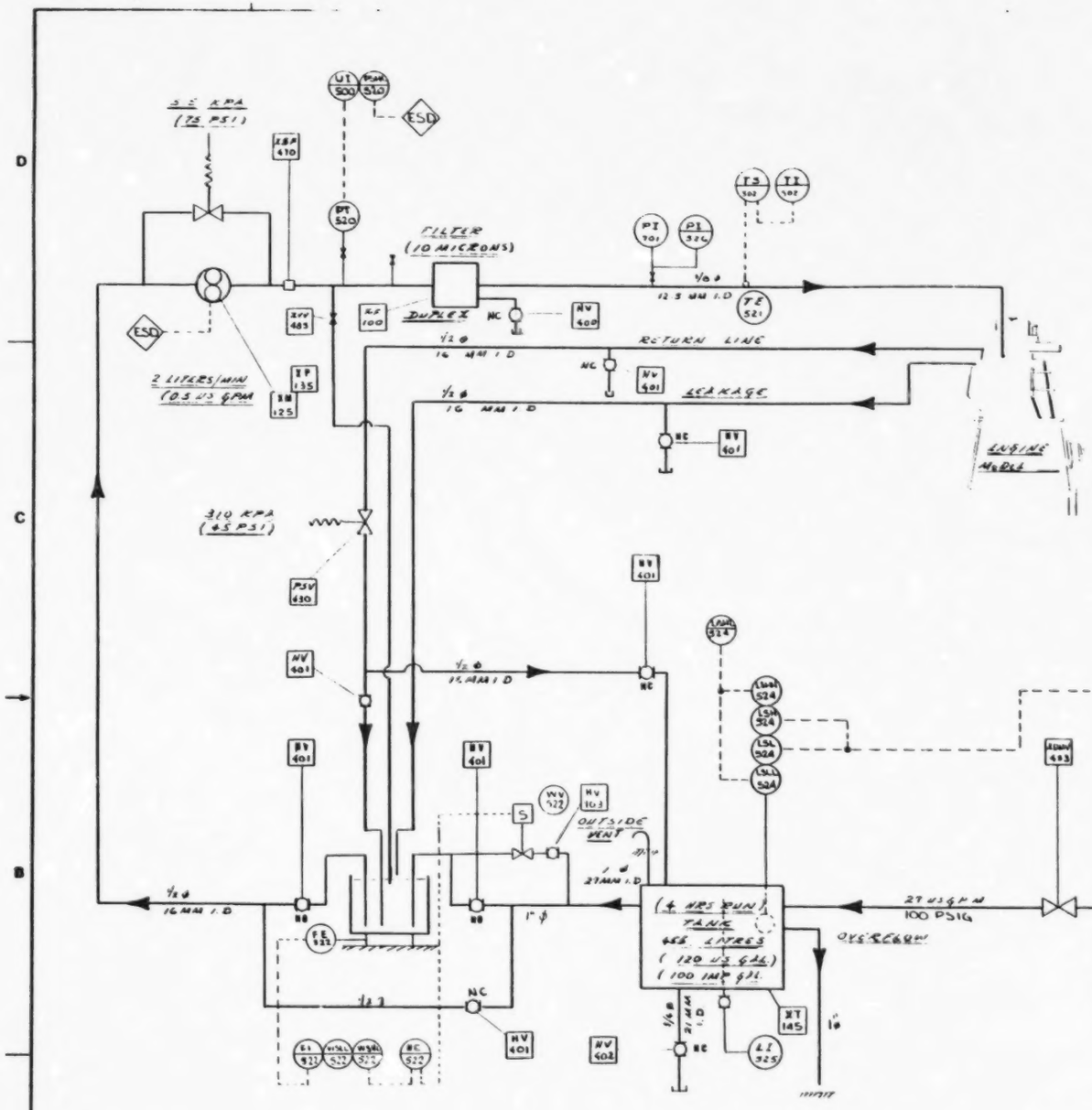


Rev	Zone	Description	Init	Date	Approved
A		GENERAL REVISION	LM	83/04/14	
B		ISSUED FOR QUOTATION		83/10/11	

FINAL ISSUE

Originator: 7666 1	PROJECTION	Bombardier Inc.					
Date: 83/12/12	TOLÉRANCE ET FINI DE SURFACE SAUF INDICATION CONTRAIRE	Division des produits ferroviaires et diesel / Rail and Diesel Products Division					
Ch. groupe: S.K.	MÉTRIQUE .000 ±.05; .0000 ±.015; .00000 ±.0005	Montreal Quebec Canada					
Date: 83-12-12	DÉCIMAL ± 1/32, ± 1/16; ± .005, ± .010	Object / Subject: ENGINE / DYNO SYSTEM LR TEST CELL Nº 7					
Document:	FRAC (BRUT) ± 1/16, ± 1/8	For: 645's Nº 67					
Date:	ANGLES ±1/2° CHANFREIN ±2°	Format: A1	Sheet: 1	Rev: B			
	ÉBAVURER 1/64 - 0.4mm MAX	Drawing No: A1-8804					
	FINI DE SURFACE 1.25 mu m VV						

FIG. II



NOTES

1) ALL INSTRUMENTATION SHUT OFF BALL VALVES ARE 1/2 DIA.

FINAL ISSUE

N°	DATE ISSUED	DISTRIBUTION
		N. STANDEN
		B. FUNG
		C. LAFONTAINE
		M. PAYNE
		S. KANDIAN
		Y. ST PIERRE
		L. MARTIN
		C. GONZALEZ
		J. DONGLL
		G. MERCHESSAULT
		R. ARCHAMBAULT
		M. MCNIRGUI

Rev.	Zone	Description	Init.
A	B3-04	GENERAL REV.	PA
B	B3-03	GENERAL REV.	PA
C	B3-02	GENERAL REVISION	LM
D	B3-01	GENERAL REV.	PA
E	B3-01	REVISED PER ECN 20-18500	AM
F	B3-01	GENERAL REV.	PA

Designer: REAL A. Date: 83 08 24
Verificator: L.M. Date: 83 12 12
Ch. groupe: S.L. Date: 83-12-14
Document:

PROJECTION

TOLÉRANCE ET FINDE SURFACE SAUF INDICATION CONTRAIRE

DÉCIMAL	0	
	0.0	± 0.1
	0.00	± 0.05
	0.000	± 0.010
FRAC. (BRUT)		± 1/16
ANGLES		CHANFREINS
ÉBAUCHER	1 mm	0.5mm MAX
FINITION SURFACE	1.25 micron	

A1

Bombardier Inc.
Division des produits ferroviaires et diesel
Rail and Diesel Products Division
Montreal Quebec Canada

FUEL OIL SYSTEM
SINGLE CYL ENG MODEL
TEST CELL N°

A1-8789

1/1

F

FIG. III

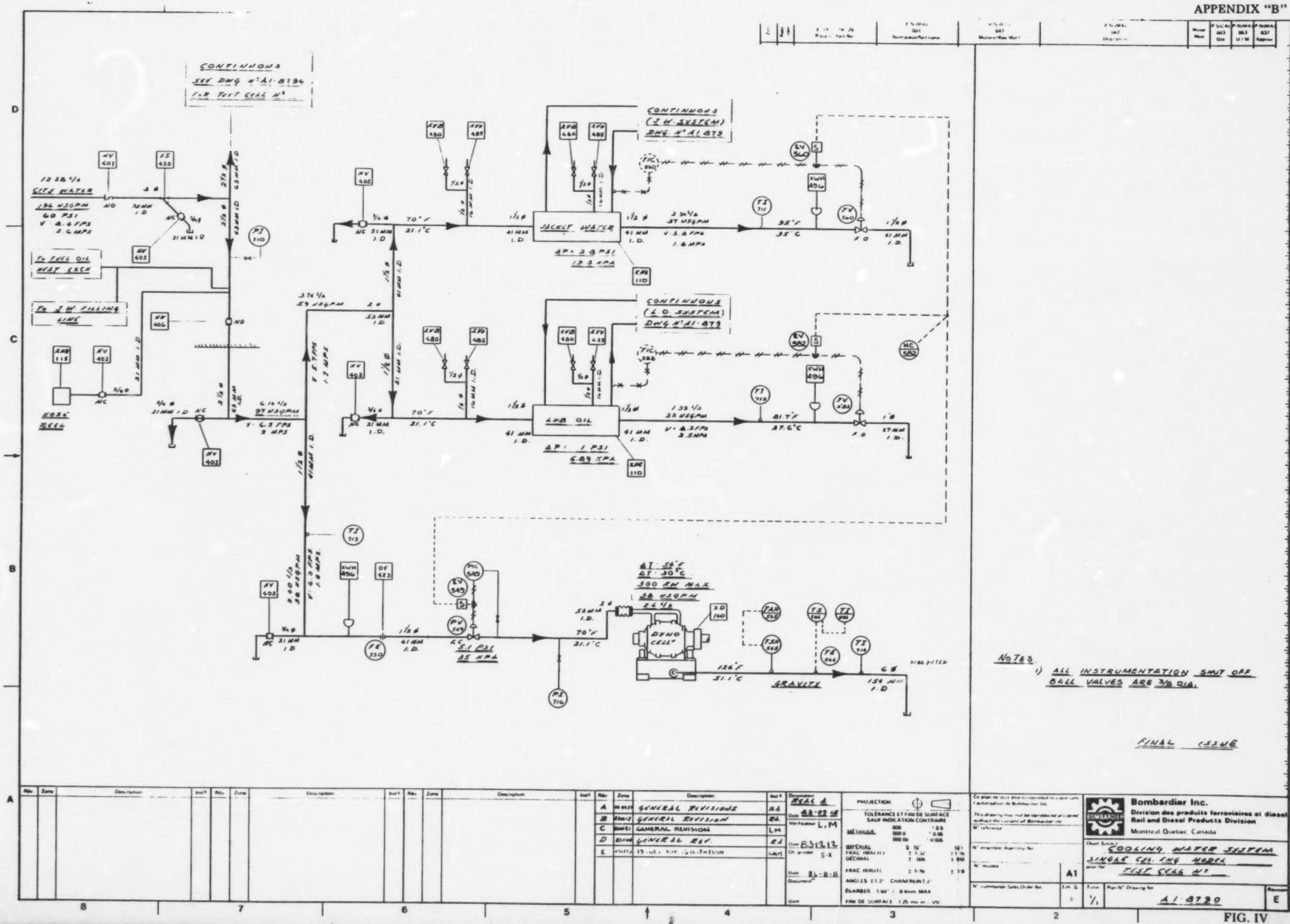

CONTINUOUS
SEE DWG N° AI-8794
FOR TEST CELL N°
12 28 1/2 GPM CITY WATER
136 USGPM 60 PSI
V = 8.6 FPS 2.6 MPS
NV 401
XS 455
NV 402
PI 710
To Fuel Oil Heat Exch
To J.W. Filling Line
NV 406
XMR 115
NV 402
NV 402
NV 403
374 1/2 59 USGPM
NV 403
XVR 480
XVR 485
NV 402
XVR 480
XVR 485
CONTINUOUS (J.W. SYSTEM) DWG. N° AI-873
JACKET WATER
41 MM I.D.
2 3/4 37 USGPM
V = 5.8 FPS 1.8 MPS
ΔP = 2.8 PSI 19.3 KPA
XMR 110
TIC 540
EV 540
S
XMR 484
FV 540
TI 711
35°F 35°C
CONTINUOUS (L.O. SYSTEM) DWG. N° AI-873
LUB OIL
41 MM I.D.
1 1/2 33 1/2 23 USGPM
V = 4.3 FPS 1.3 MPS
ΔP = 1 PSI 6.89 KPA
XMR 110
TIC 580
EV 582
S
XMR 484
FV 584
FI 713
81.7°F 27.6°C
HC 582
NV 402
FE 550
PIC 540
EV 549
S
PV 549
ΔT = 55°F ΔT = 30°C
300 RPM MAX
28 USGPM 2 1/2
DYNO CELL
XD 160
TAH 562
TSH 568
TS 566
TI 566
TE 566
TI 914
126°F 51.1°C
GRAVITY
6"
159 MM I.D
PI 716
NOTES
1) ALL INSTRUMENTATION SHUT OFF BALL VALVES ARE 3/8 DIA.
FINAL ISSUE
Bombardier Inc.
Division des produits ferroviaires et diesel
Rail and Diesel Products Division
Montreal Quebec Canada
COOLING WATER SYSTEM
SINGLE CYL. ENG MODEL
TEST CELL N°
AI-8720
E
A1
PROJECTION
TOLÉRANCES ET FINI DE SURFACE SAUF INDICATION CONTRAIRE
A 83-12 GENERAL REVISIONS
B 83-12 GENERAL REVISION
C 83-11 GENERAL REVISION
D 83-08 GENERAL REV.
E 83-07 REVISION
Design REAL A
Date 83-02-16
Verificateur L.M
Date 83-12-12
Ch. projet S.K
Date 84-8-8

FIG. IV

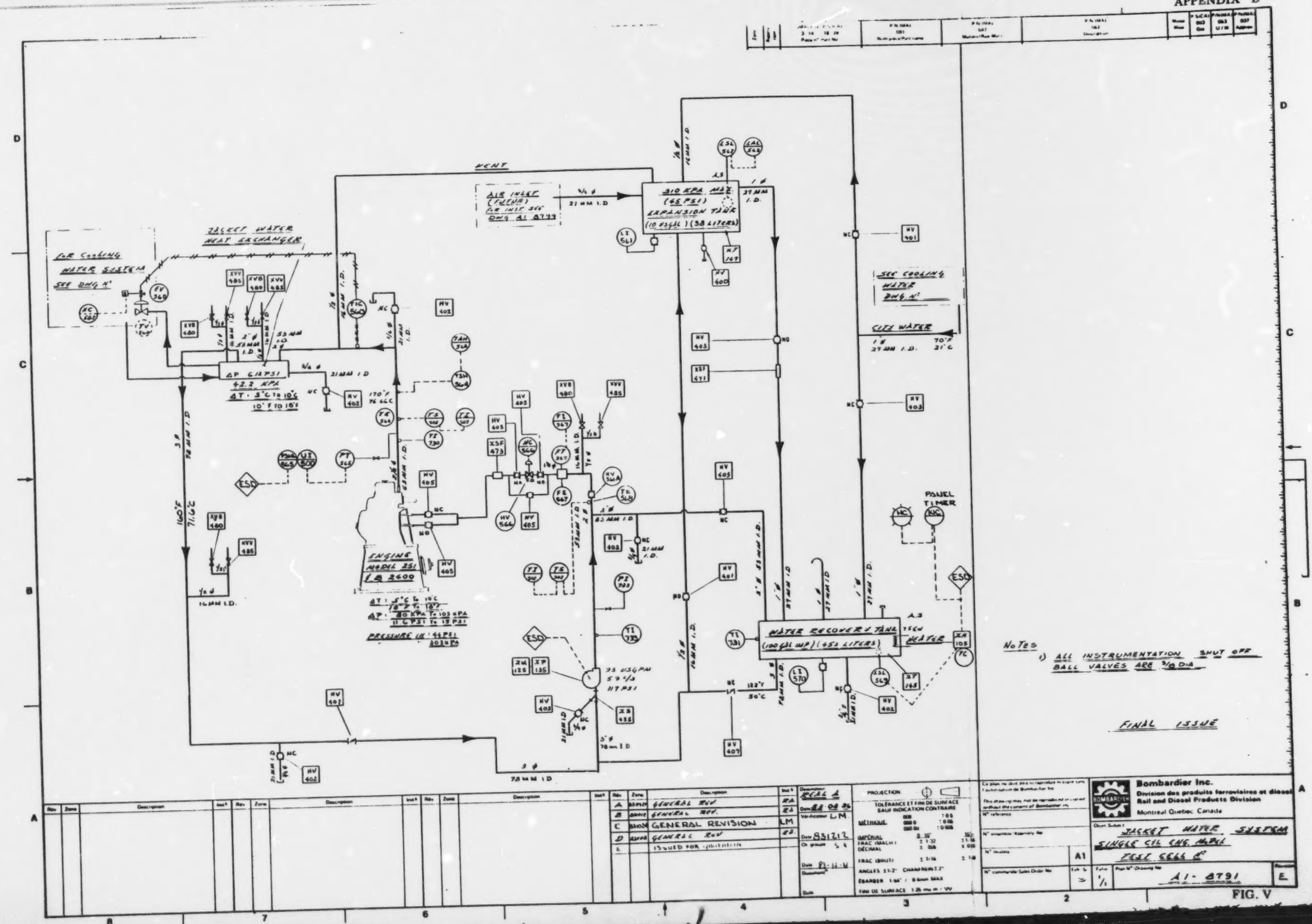
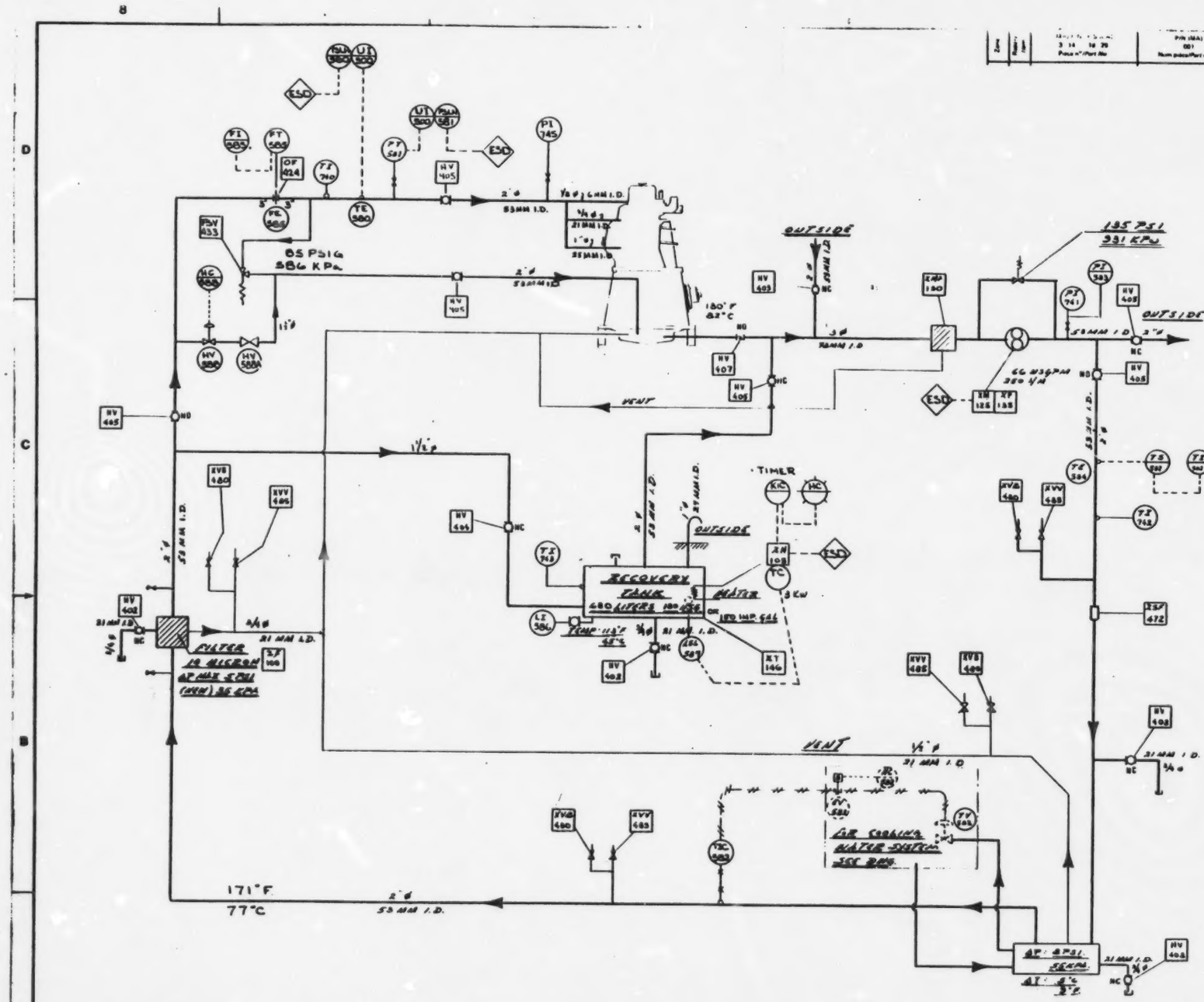

JACKET WATER HEAT EXCHANGER
AIR INLET (FUSEUR) SEE INST 366 DWG AI 8793
3/4" 21 MM I.D
310 KPA MAX (45 PSI) EXPANSION TANK (10 USGAL) (38 LITERS)
1" 29 MM I.D.
VENT
SEE COOLING WATER DWG N°
CITY WATER
1" 29 MM I.D. 70°F 21°C
ΔP 6 KPA 1 PSI
42.2 KPA
ΔT : 5°C TO 10°C
10° F TO 15° F
170°F 76.6°C
100°F 37.8°C
ENGINE MODEL 251 LQ 2600
ΔT : 5°C TO 10°C
10°F TO 15°F
ΔP : 80 KPA TO 103 KPA
11.6 PSI TO 15 PSI
PRESSURE IR : 44 PSI 303 KPA
93 USGPM 59 1/3 H.P.S.I
WATER RECOVERY TANK (100 GAL IMP) (455 LITERS)
HEATER
PANEL TIMER
132°F 56°C
NOTES
1) ALL INSTRUMENTATION SHUT OFF BALL VALVES ARE 3/8 DIA
FINAL ISSUE
Bombardier Inc.
Division des produits ferroviaires et diesel
Rail and Diesel Products Division
Montreal Quebec Canada
JACKET WATER SYSTEM
SINGLE CYL ENG. MODEL
TEST CELL N°
A1 - 8791
A1
1/1
E
PROJECTION
TOLÉRANCE ET FINI DE SURFACE
SAUF INDICATION CONTRAIRE
DESSINÉ KEAL 4
VÉRIFIÉ LM
DATE 83 12 12
DATE 83-12-14

FIG. V



Rév.	Zone	Description	Init.
A		GENERAL REV.	RA
B		GENERAL REV.	RA
C		GENERAL REVISION	LM
D		GENERAL REV.	RA
E		ISSUED FOR QUOTATION	GAM
F		GENERAL REV.	MAA

Dessinateur: RAGAI M.
Date: 88-04-05
Vérification: L.M.
Date: 88/12/12
Gr. groupe: S.K
Date: 87-11-17
Date:

PROJECTION:

TOLÉRANCE ET FINI DE SURFACE SAUF INDICATION CONTRAIRE

MÉTRIQUE	000	± 0.5
	000.0	± 0.05
	000.00	± 0.005
IMPÉRIAL	X.XX"	XX°
FRAC (MACH.)	± 1/32	± 1°/6
DÉCIMAL	± .005	± .5°
FRAC (BRUT)	± 1/16	± 1°

ANGLES: 2 1/2° CHANFREIN 2.2°
ÉBARBER 1/64" / 0.4mm MAX
FINI DE SURFACE 1.25 mu m / 125

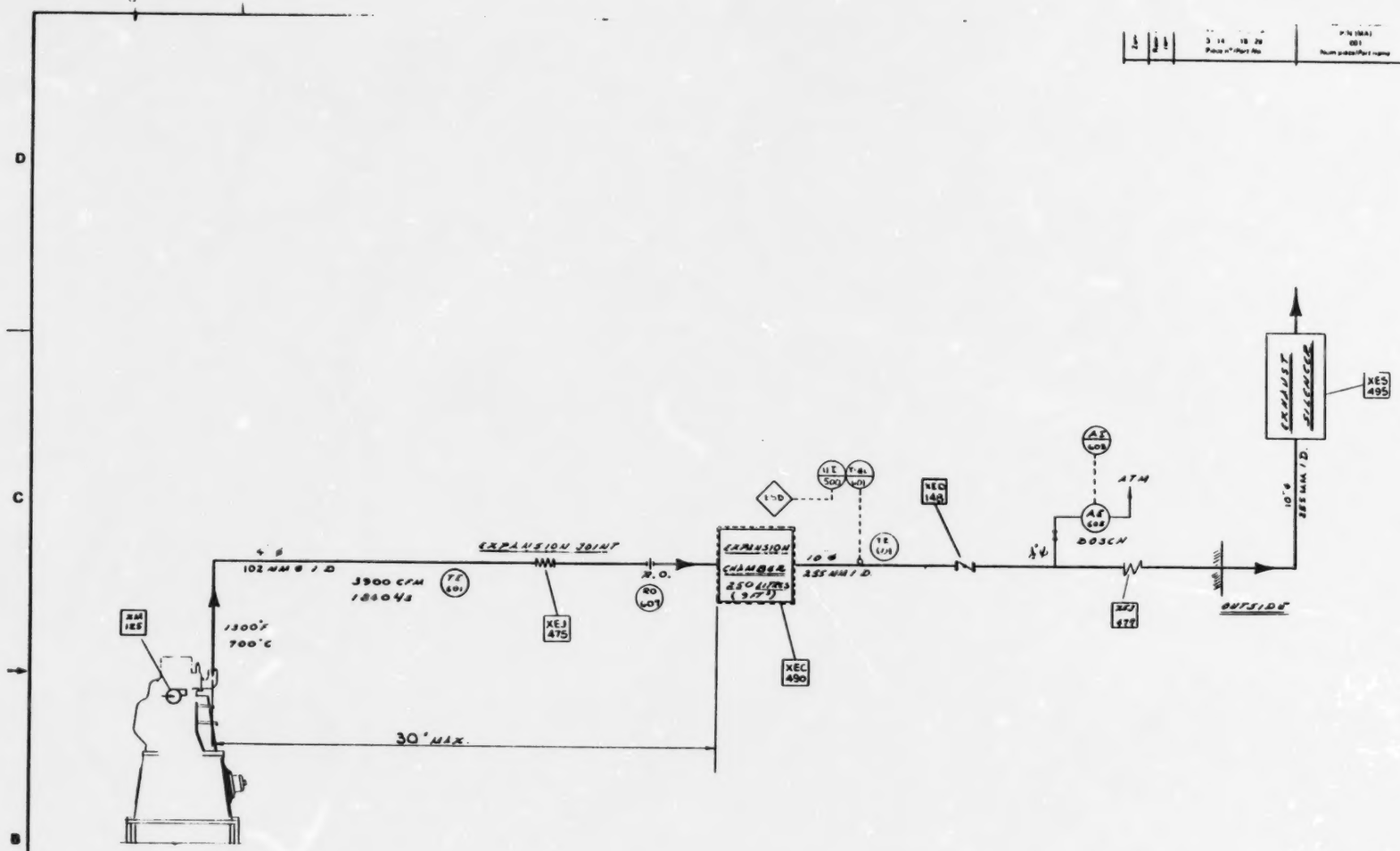
Ce plan ne doit être ni reproduit ni copié sans l'autorisation de Bombardier Inc.
This drawing may not be reproduced or copied without the consent of Bombardier Inc.

N° référence:
N° ensemble/Assembly No:
N° modèle: A1
N° commande/Sales Order No: Sch. No: 2
Échelle: 1/1
Plan N° d'ensemble No: AI 8792 F

Bombardier Inc.
Division des produits ferroviaires et diesel
Rail and Diesel Products Division
Montreal, Quebec, Canada

Objet/Subject: LUB OIL SYSTEM
SUREAU SIL. 145 MPH
TEST CELL

FIG. VI



FINAL ISSUE

Rév	Zone	Description	Init°
A		GENERAL REV	RL
B		GENERAL REV.	RA
C		GENERAL REVISION	LM
D		GENERAL REV.	RL
E		ISSUED FOR QUOTATION	LM

Dessinateur: REAL L.
Date: 88-09-20
Vérificateur: L.M
Date: 88/12/13
Ch. groupe: S.V.
Date: 88-12-21
Document N°:
Date:

PROJECTION

TOLÉRANCE ET FINI DE SURFACE SAUF INDICATION CONTRAIRE

MÉTRIQUE	000	± 0.5
	000.0	± 0.05
	000.00	± 0.005
IMPÉRIAL	0-10"	10"-
FRAC (MACH.)	± 1/32	± 1/64
DÉCIMAL	± .005	± .010
FRAC (BRUT)	± 1/16	± 1/8

ANGLES ±1/2° CHANFREIN ± 2°
ÉBARBER 1/64" - 0.4mm MAX
FINI DE SURFACE 1.25 my m - VV

Ce plan ne doit être ni reproduit ni copié sans l'autorisation de Bombardier Inc.
This drawing may not be reproduced or copied without the consent of Bombardier Inc.

N° référence:
N° ensemble/Assembly No:
N° modèle:
N° commande/Sales Order No:

A1

Échelle: 1
Feuille: 1

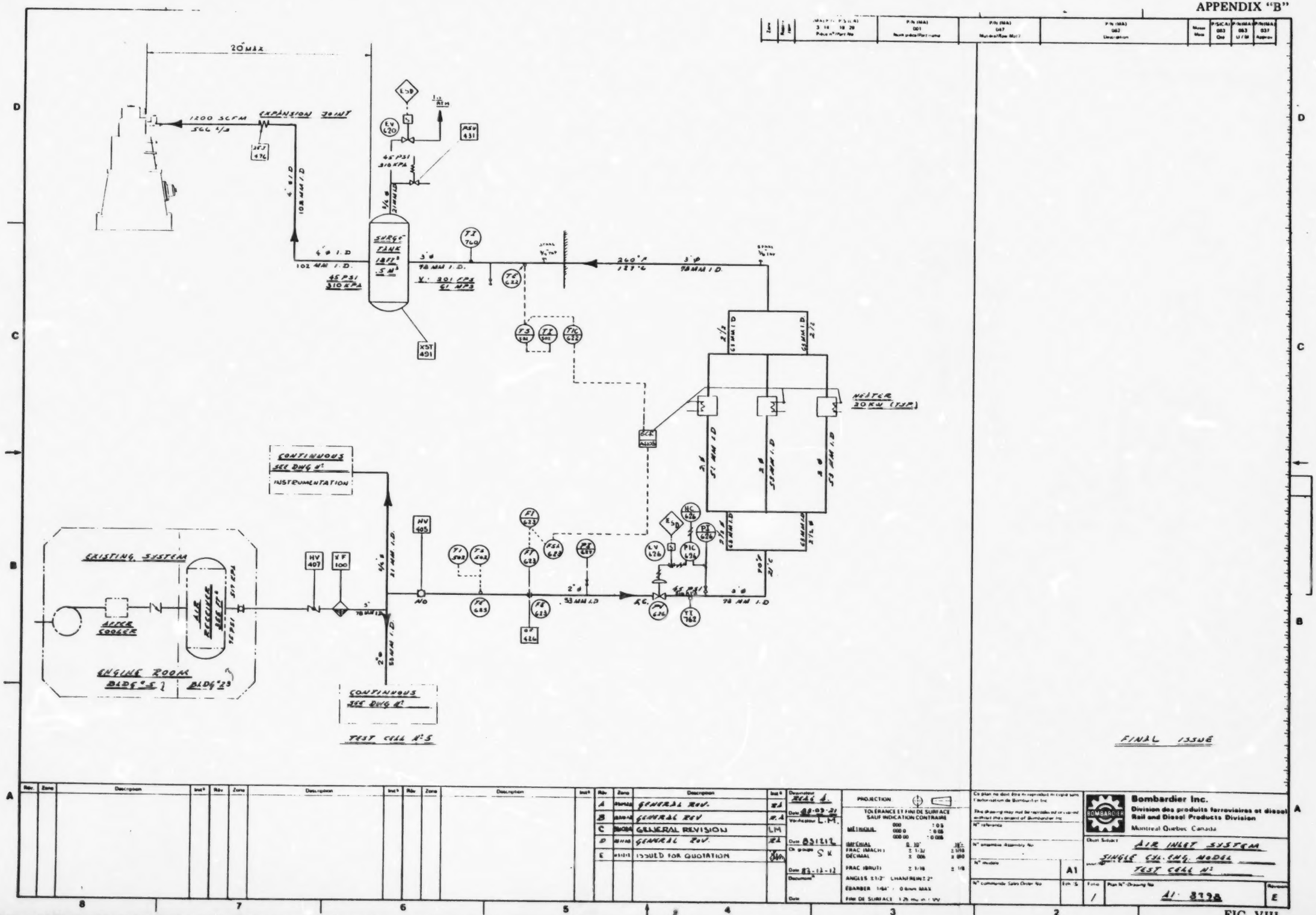
Bombardier Inc.
Division des produits ferroviaires et diesel
Rail and Diesel Products Division
Montreal Quebec Canada

Objet/Subject: EXHAUST SYSTEM
SINGLE CYL ENG MODEL
TEST CELL N°

Plan N° Drawing No: A1-8797

Révision: E

FIG. VII



Rev.	Zone	Description	Init°	Rev.	Zone	Description	Init°	Rev.	Zone	Description	Init°
A		GENERAL REV.	RL								
B		GENERAL REV	R.A								
C		GENERAL REVISION	LM								
D		GENERAL REV.	RL								
E		ISSUED FOR QUOTATION									

Description: REAC 4.
Date: 88-03-24
Vérificateur: L.M.
Date: 03/11/12
Dr. projet: S.K.
Date: 83-12-12
Document°:
Date:

PROJECTION

TOLÉRANCE ET FINI DE SURFACE SAUF INDICATION CONTRAIRE

MÉTRIQUE	000	± 0.5
	000 0	± 0.05
	000 00	± 0.005
IMPÉRIAL	0, 10"	ANG.
FRAC (MACH.)	± 1/32	± 5/60
DÉCIMAL	± .005	± 0°0
FRAC (BRUT)	± 1/16	± 1/8

ANGLES ± 1/2° CHANFREIN 2 x 2°
ÉBARBER 1/64" / 0.4mm MAX
Fini DE SURFACE 1.25 my m / VV

Ce plan ne doit être reproduit ni copié sans l'autorisation de Bombardier Inc.
This drawing may not be reproduced or copied without the consent of Bombardier Inc.

N° référence:
N° assemblage Assembly No:
N° modèle: A1
N° commande Sales Order No: Ech: S

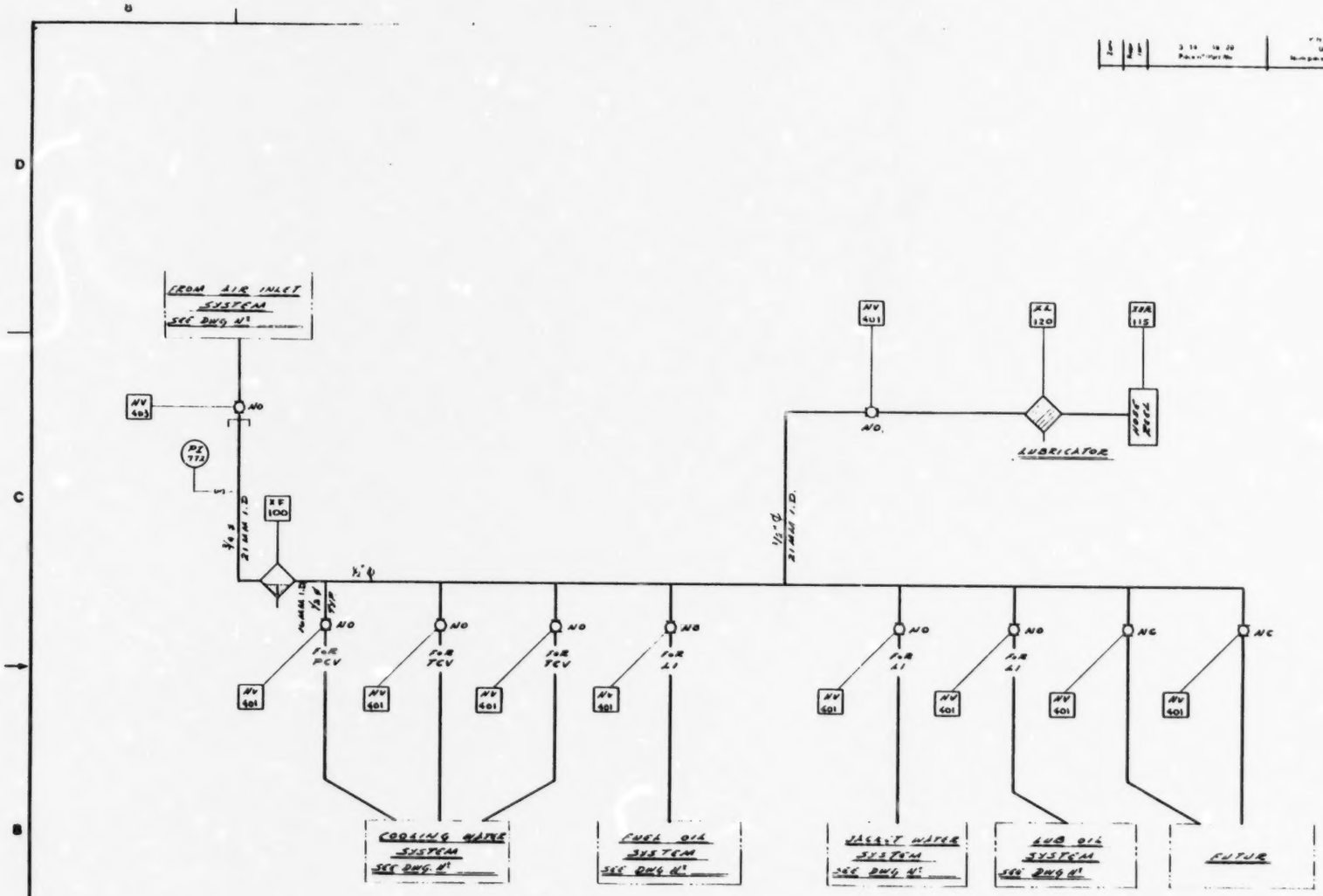
Bombardier Inc.
Division des produits ferroviaires et diesel
Rail and Diesel Products Division
Montreal Quebec Canada

Dwg Subject: AIR INLET SYSTEM
SINGLE CYL. ENG. MODEL
TEST CELL N°1

Plan N° (Drawing No): A1 8798
Feuille: 1
Révision: E

FINAL ISSUE

FIG. VIII



Rev	Zone	Description	Init	Date
A		GENERAL REV.	RJ	
B		GENERAL REV.	RJ	
C		GENERAL REV	RJ	
D		ISSUED FOR DISTRIBUTION	RJ	
E		GENERAL REV.	RJ	

Dessiné RVL 1 — Date 93-09-21
Vérifié L.M — Date 93-11-16
Date 93-12-16

PROJECTION

TOLÉRANCE ET FINI DE SURFACE SAUF INDICATION CONTRAIRE

DÉCIMAL .000 ±.05 .0000 ±.025 .00001 ±.0125
IMPÉRIAL 0 30' ±30'
FRAC (BASE) ± 1/32 ±1/64
DÉCIMAL ± .005 ± .010
FRAC (BASE) ± 1/16 ± 1/8
ANGLES ± 1/2° CHAMFREIN ± 2
ÉBAVURER 1.00" Ø 0mm MAX
FINI DE SURFACE 1.25 max en VV

A1

Bombardier inc.
Division des produits ferroviaires et diesel
Rail and Diesel Products Division
Montreal Quebec Canada

INSTRUMENTATION
SINGLE CYL ENG MODEL N°
TEST CELL N°

A1 02739

1 / 6

FINAL ISSUE

FIG. IX

BOMBARDIER INC.
DIVISION DES PRODUITS FERROVIAIRES ET DIESEL
1505 DICKSON, MONTREAL, QUE. H1N 2H7

SHEET NO. 1
PROJ. NO. 484235
DATE 12/19/83

****INSTRUMENT INDEX LIST****

TAG NUMBER		DESCRIPTION
	500	PANEL MULTIVARIABLE INSTRUMENT
U	500	INDICATOR/HILO TRIP MICROPROCESSOR BASED
	502	PANEL TEMPERATURE INDICATION
TI	502	DIGITAL INDICATOR
TS	502	SELECTOR SWITCH "J" TYPE T/C
	503	PANEL 24 VOLT DISTRIBUTION
X	503	24 VOLTS POWER SUPPLY
	504	CONTROL ROOM MAIN PANEL
X	504	PANEL
	520	FPENIN.PI/ESD
PSHL	520	4-20 MA CARD IN U 500
PT	520	PRESSURE TRANSMITTER
	521	FTENIN-TI
TE	521	J T/C
	522	FPENIN.FI
FE	522	LOAD CELL
FIWSHL	522	WEIGHT SCALE MONITOR
HC	522	ELECTRICAL SWITCH
WV	522	SOLENOID VALVE
X	522	HAMMOND ENCLOSURE
	524	FDBUTK.LC
LAHL	524	PANEL ALARM / BY ELECTRICAL DEPT
LSHH	H524	FLOAT LEVEL SWITCH
LSLL	L524	FLOAT LEVEL SWITCH
LV	524	SOLENOID VALVE
	525	FDBUTK.LI
LI	525	PRESSURE GAUGE
	526	FPENIN.PI
PI	526	PRESSURE GAUGE
	544	CTDVOT.TI
TE	544	J T/C
	545	CTDVOT.TAH
TAH	545	ALARM / BY ELECTRICAL DEPT
TSH	545	FIELD TEMPERATURE SWITCH
	549	CPDVIN.PIC
EV	549	SOLENOID VALVE / PART OF PV549
PC	549	FIELD PRESSURE CONTROLLER
PV	549	CONTROL VALVE

Fig. X-1

BOMBARDIER INC.
DIVISION DES PRODUITS FERROVIAIRES ET DIESEL
1505 DICKSON, MONTREAL, QUE. H1N 2H7

SHEET NO. 2
PROJ. NO. 484235
DATE 12/19/83

****INSTRUMENT INDEX LIST****

TAG NUMBER		DESCRIPTION
	550	CFDVIN.FE
FE	550	ORIFICE RUN
	560	JTENOT.TIC
EV	560	SOLENLOID VALVE / PART OF TV 560
TC	560	FIELD INDICATOR CONTROLLER
TV	560	CONTROL VALVE
	561	JDEXTK.LI
LI	561	SIDE SIGTH GLASS / BV MECHANICAL DEPT
	562	JDEXTK.LAL
LAL	562	PANEL ALARM
LSL	562	FLOAT LEVEL SWITCH
	564	JTENOT.TIAH
TAH	564	PANEL ALARM
TE	564	J T/C
TSH	564	FIELD TEMPERATURE SWITCH
	565	JPENOT.PI/ESD
PSHL	565	4-20 MA CARD IN UI 500
PT	565	PRESSURE TRANSMITTER
	566	JFENIN.HC
HC	566	PANEL PUSHBUTTON
HV	566	BALL VALVE WITH MOTORISED ACTUATION
HV	566A	MANUAL VALVE
	567	JFENIN.FI
FE	567	MAGMETER
FI	567	PANEL AMMETER
FT	567	MAGMETER
	568	JTENIN.TI
TE	568	J T/C
	569	JDRYTK.LSL
LSL	569	FLOAT LEVEL SWITCH
	570	JDRYTK.LI
LI	570	PRESSURE GAUGE
	580	LTENIN.TI/ESD
TE	580	J T/C
TSHL	580	'J' T/C CARD IN UI 500
	581	LPENIN.PI/ESD
PSHL	581	4-20 MA CARD IN UI 500
PT	581	PRESSURE TRANSMITTER

Fig. X-2

BOMBARDIER INC.
DIVISION DES PRODUITS FERROVIAIRES ET DIESEL
1505 DICKSON, MONTREAL, QUE. H1N 2H7

SHEET NO. 3
PROJ. NO. 484235
DATE 12/19/83

*****INSTRUMENT INDEX LIST*****

TAG NUMBER		DESCRIPTION
	582	LTENIN.TIC
EV	582	SOLENOID VALVE / PART OF TV582
HC	582	PANEL PUSHBUTTON
TC	582	FIELD INDICATOR CONTROLLER
TV	582	CONTROL VALVE
	583	LPX3IN.PI
PI	583	PRESSURE GAUGE
	584	LTX3IN.PI
TE	584	J T/C
	585	LFENIN.FI
FE	585	ORIFICE RUN
FI	585	PANEL AMMETER
FT	585	D/P CELL
	586	LDRYTK.LI
LI	586	PRESSURE GAUGE
	587	LDRYTV.LSL
LSL	587	FLOAT LEVEL SWITCH
	588	LFENDI.HC
HC	588	PUSHBUTTON
HV	588	BALL VALVE WITH MOTORISED ACTUATION
HV	588 A	MANUAL VALVE
	601	ETENOT.TI/ESD
TE	601	J T/C
TSHL	601	'J' T/C CARD IN UI 500
	607	EFENOT.RO
RO	607	ORIFICE RUN
	620	APENDI.ESD
EV	620	SOLENOID VALVE
	622	ATENIN.TIC
TE	622	J T/C
TIC	622	PANEL TEMPERATURE CONTROLLER
	623	AFENIN.FI
FE	623	ORIFICE RUN
FE	623 1	ORIFICE RUN
FI	623	PANEL AMMETER
FSL	623	4-20 MA TRIP RELAY
FT	623	D/P CELL
	625	ATCUIN.TI
TE	625	J T/C

Fig. X-3

BOMBARDIER INC.
DIVISION DES PRODUITS FERROVIAIRES ET DIESEL
1505 DICKSON, MONTREAL, QUE. H1N 2H7

SHEET NO. 4
PROJ. NO. 484235
DATE 12/19/83

*****INSTRUMENT INDEX LIST*****

TAG NUMBER		DESCRIPTION
626		APENIN.PIC
EV	626	SOLENOID VALVE / PART OF PV626
HC	626	PANEL MANUAL LOADER
PI	626	PRESSURE GAUGE
PIC	626	FIELD PRESS. CONT. WITH REMOTE SET POINT
PV	626	CONTROL VALVE
627		APCVIN.PI
PI	627	PRESSURE GAUGE
640		APCVIN.PIC
PCV	640	REGULATOR
641		APSTIN.HC
HC	641	PUSHBUTTON
HV	641	SOLENOID VALVE
660		XSEN.HC
HC	660	LEVER AND POTENTIOMETER
HC	660 A	POTENTIOMETER, IDLE SPEED ADJUSTMENT
HC	660 B	PUSHBUTTON BY ELECTRICAL DEPT.
SC	660	SPEED GOVERNOR/CONTROLLER
SZ	660	GOVERNOR ACTUATOR
661		ATCELL.TI/ESD
TE	661	J T/C
TSHL	661	'J' T/C CARD IN UI 500
664		S/WDY.S/WICAHL/ESD
HC	664	LEVER AND POTENTIOMETER
KQI	664	ELAPSE TIME COUNTER
SI	664 A	DIGITAL SPEED INDICATOR
SSHL	664	0-5 VOLT CARD IN UI 500
SSL	664 1	4-20 MA TRIP RELAY
SSL	664 2	LIMIT SWITCH ON LEVER
SWIC	664	SCHENK UNIT
WS AL	664	PANEL ALARM
WSHL	664	0-5 VOLT CARD IN UI 500
WSL	664	LIMIT SWITCH ON LEVER
665		MTENHD.TI/ESD
TE	665	'J' T/C
TSHL	665	'J' T/C CARD IN UI 500
666		MTENLR.TI/ESD
TE	666	'J' T/C
TSHL	666	'J' T/C CARD IN UI 500

Fig. X-4

APPENDIX B

GLOSSARY OF SYMBOLS

FOR SCHEMATIC DIAGRAMS

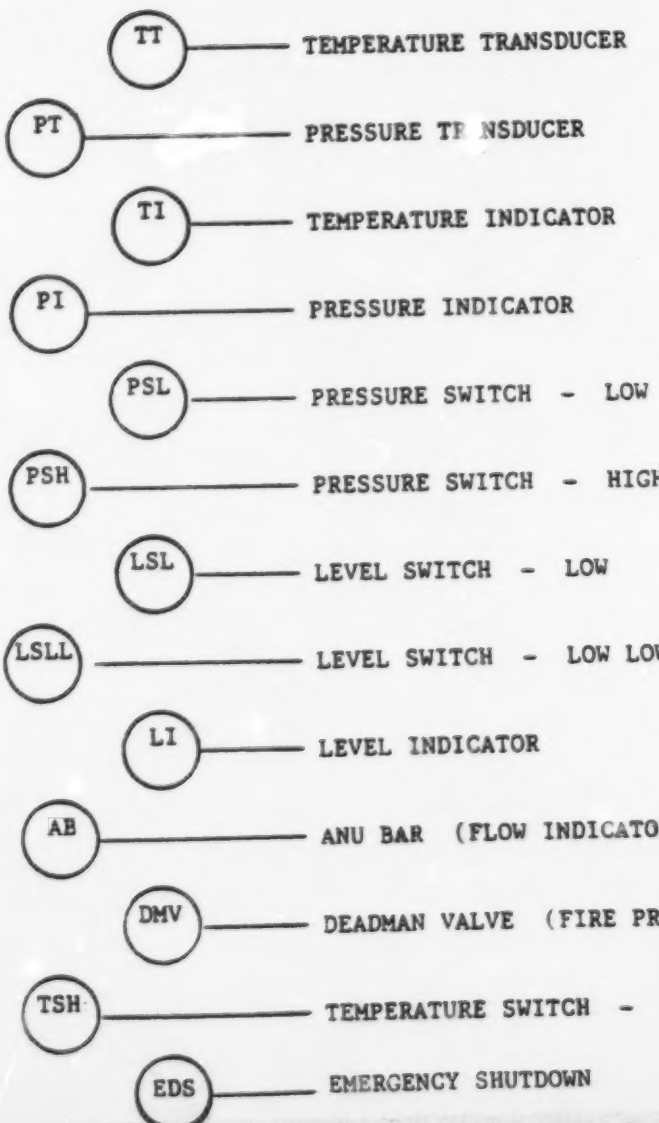
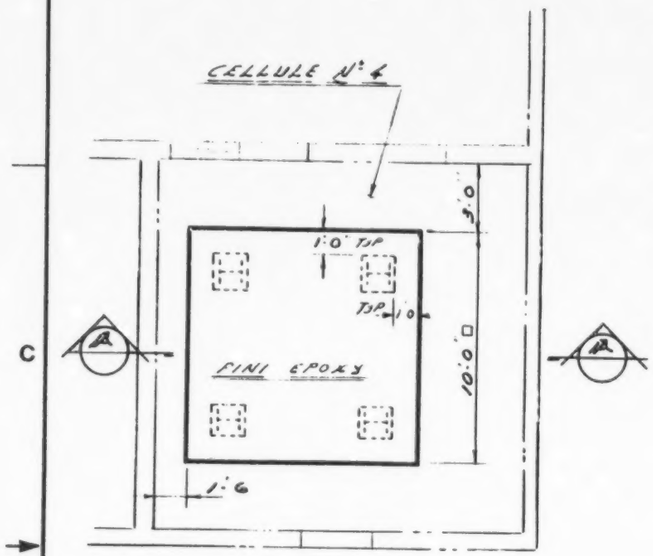
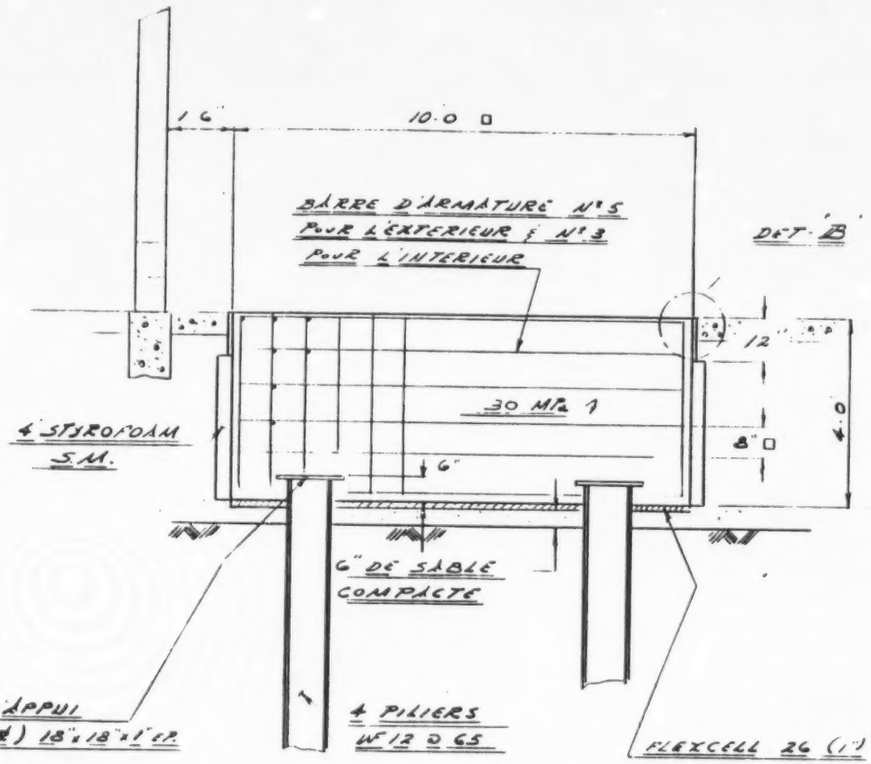
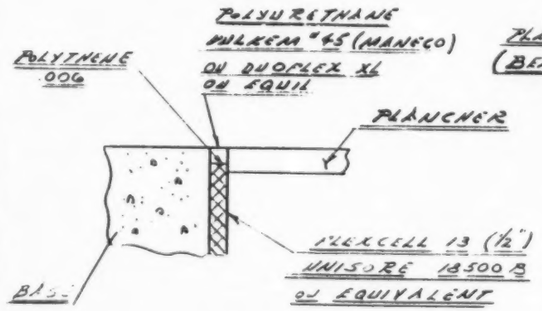


FIG. XI

Rév. Rev. Item	(MA) P/N P S (CA) 3 14 18 29 Piece n° / Part No	P N (MA) 001 Num piece/Part name	P/N (MA) 047 Matière/Raw Mat'l	P N (MA) 062 Description	Masse Mass	P S(CA) 003 Qte	P N(MA) 053 U / M	P N(MA) 037 Appro.







DETAIL - "B"

SECTION A - A

NOTES

1) PILIER DESCENDRE JUSQUA LA ROCHE SOLIDE 40'-0 APPR. VOIR ETUDE DE SOL EFFECTUE PAR GEOCON DATE DU 80-10-14

2) PREVOIR 10 BOULONS D'ANCRAGES SERONT LOCALISES PLUS TARD

3) POUR SOUMISSION SEULEMENT

Rév.	Zone	Description	Init's
A	C 3	RELOCALISE LES PILIERS	RL

Dessinateur: REAL L.
Date: 83-09-07
Vérificateur:
Date:
Ch. groupe:
Date:
Documents:
Date: 83 10 07

PROJECTION

TOLÉRANCE ET FINI DE SURFACE SAUF INDICATION CONTRAIRE

MÉTRIQUE	000	±0.5
	000 0	±0.05
	000 00	±0.005

IMPÉRIAL	0 - 10"	10"+
FRAC (MACH.)	± 1/32	± 1/16
DÉCIMAL	± .005	± .010
FRAC (BRUT)	± 1/16	± 1/8

ANGLES: ± 1/2° CHANFREIN ± 2°
ÉBARBER 1/64" / 0.4mm Max
FINI DE SURFACE 1.25 mu m / VV

Ce plan ne doit être ni reproduit ni copié sans l'autorisation de Bombardier Inc
This drawing may not be reproduced or copied without the consent of Bombardier Inc

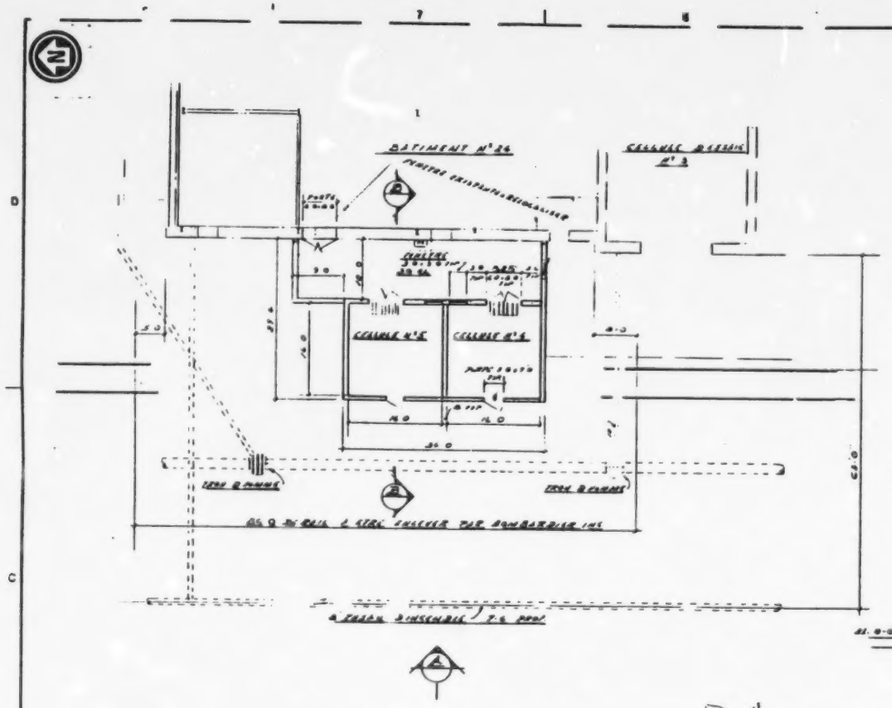
N° référence:
N° ensemble/Assembly No:
N° modèle: A2
N° commande/Sales Order No:
Ech./Sc. 1/2 : 1 0 / 1/4 : 1 0
Folio 1/1

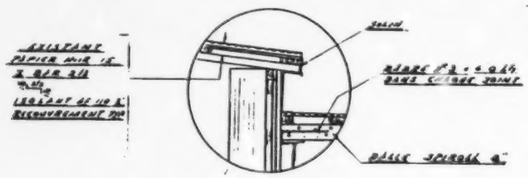
Bombardier Inc.
Division des produits ferroviaires et diesel
Rail and Diesel Products Division
Montreal, Quebec, Canada

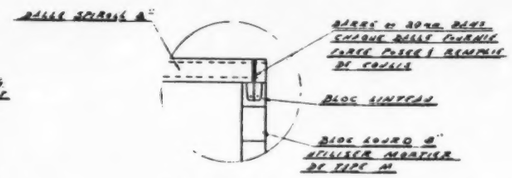
Objet/Subject: FONDATION SUR MOTEUR (ENGINE FOUNDATION) CELLULE 4 & 5
pour/for: BATIMENT N° 67

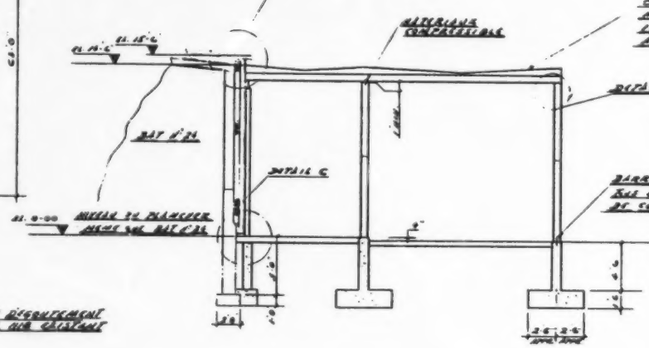
Plan N°/Drawing No: A2-8788
Révision: A

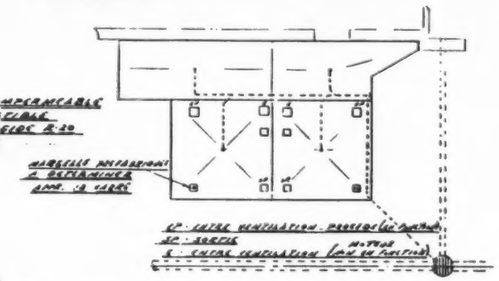
FIG. XII

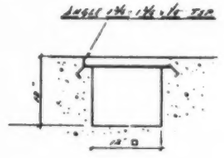


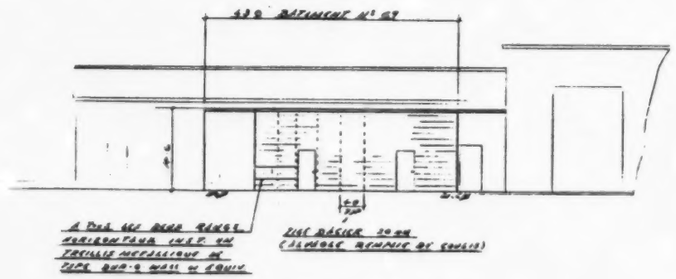


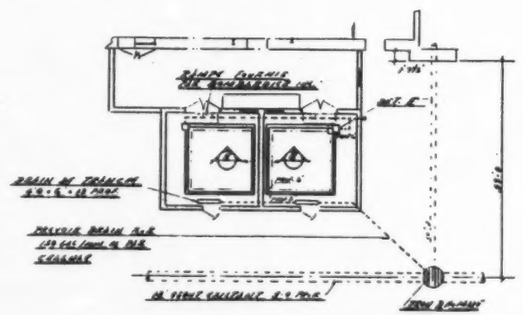

DALLE SOUPAPE 4"
BARRE DE 20 MM. DIAM. SCELLÉE DALLE FONDUE FORTE POSER À REMPLIR DE COULIS
BLOC LINTEAU
BLOC LOURD 8" RÉALISER MORTIER DE TYPE M
DETAIL D

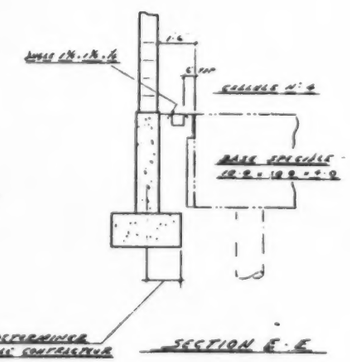












Notes

1) TOUTES LES DIMENSIONS SONT PRISES SUR SOUDURE. UN DESSIN DÉTAILLÉ DE CONSTRUCTION DEVRA ÊTRE SOUMIS PAR L'ENTREPRENEUR ET APPROUVÉ PAR UN INGÉNIEUR QUALIFIÉ.

2) POUR SOUDS DE SOL ADJACENTS VOIR DESSINS CIVILS N° AO-12-15.

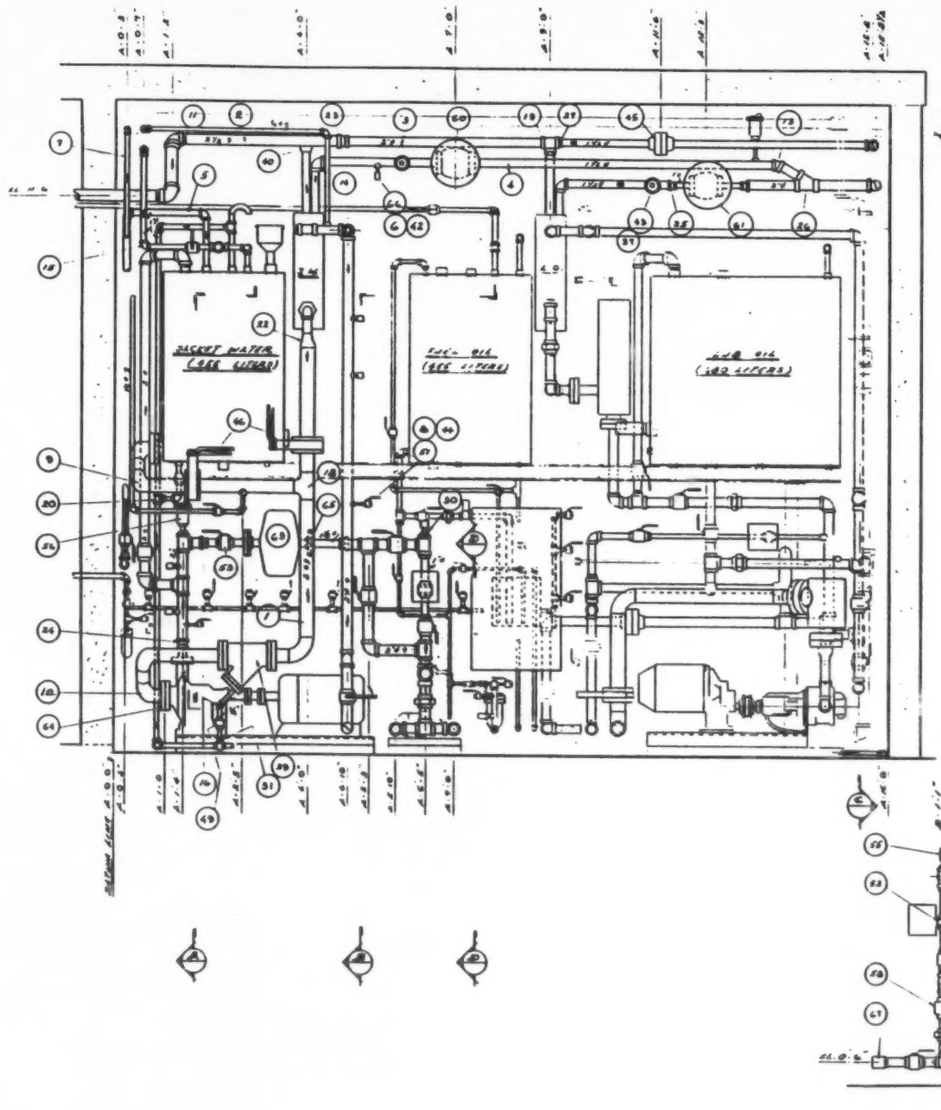
3) [ ] INDIQUE SOUDURE CONTINUE AVEC DEUX SOUDS 6".

DEPT. INGÉNIERIE D'USINE

Bombardier Inc.
Produits des produits ferroviaires et divers
Rail and Diesel Products Division
Montréal Québec Canada

R.I.D. CELLULE 5 & 6
BATIMENT N° 62

AO-8772



ITEM	QTY	DESCRIPTION	SUPPLIED
66	2	BUTTERFLY 8	BOMBARDIER
67	6	BALL VALVE 2" APOLLO 70-6100	
68	2	BALL VALVE 1" APOLLO 70-6100	
69	1	BALL VALVE ¾ APOLLO 70-6100	
70	3	BALL VALVE ½ APOLLO 70-6100	
71	3	BALL VALVE ¾ APOLLO 70-6100	
72	1	BALL VALVE 1" MODEL (2-PCS)	
73	1	BALL VALVE 1½ MODEL (2-PCS)	
74	1	VACUUM BRACKET 1½	
75	2	LEVER VENT ½	
76	2	WATER HAMMER ARRESTOR ½	
77	1	FLOW INDICATOR 2"	
78	1	FLOW INDICATOR 2"	
79	1	CONTROL VALVE 1½ (TWO-WAY)	
80	1	CONTROL VALVE 1" (TWO-WAY)	
81	1	CONTROL VALVE 1" (THREE-WAY)	
82	1	FLOW METER 1½" (2-PCS)	
83	4	FLANGE 3" 150 LBS	CONTRACTOR
84	3	FLANGE 1½" 150 LBS	
85	2	COUPLING ¾	
86	3	COUPLING 2"	
87	1	ELBOW 45° 1" CLASS 150	

ITEM	QTY	DESCRIPTION	SUPPLIED
1	150	2 PIPE SCH 40	CONTRACTOR
2	90	1½ PIPE SCH 40	
3	600	1 PIPE SCH 40	
4	240	1½ PIPE SCH 40	
5	630	1 PIPE SCH 40	
6	50	¾ PIPE SCH 40	
7	35 ft	½ PIPE SCH 40	
8	20 ft	¾ PIPE SCH 40	
9	2	ELBOW 3" SWEPT 9 370 90°	
10	3	ELBOW 2 1/2 R 370 90°	
11	2	ELBOW 2½ CLASS 150 90°	
12	14	ELBOW 2 CLASS 150 90°	
13	1	ELBOW 1½ CLASS 150 90°	
14	2	ELBOW 1½ CLASS 150 90°	
15	12	ELBOW 1" CLASS 150 90°	
16	1	ELBOW ¾ CLASS 150 90°	
17	6	ELBOW ½ CLASS 150 90°	
18	1	TEE 3" SCH 40	
19	9	TEE 2" CLASS 150	
20	6	TEE 1" CLASS 150	
21	1	TEE ½ CLASS 150	
22	1	REDUCER 3"x2" SCH 40	
23	1	REDUCER 2"x1½ CLASS 150	
24	2	REDUCER 2 TO 1½ CLASS 150	
25	8	REDUCER 1½ TO 1" CLASS 150	
26	1	3 LATERAL 90° CLASS 150	
27	3	BUSHING HEX 2 TO 1½	
28	3	BUSHING HEX 2 TO 1	
29	2	BUSHING HEX 2 TO ¾	
30	2	BUSHING HEX 2 TO ½	
31	1	BUSHING HEX 1 TO ¾	
32	1	BUSHING HEX 1 TO ½	
33		UNION 2x2	
34		UNION 2	
35		UNION 1½	
36		UNION 1	
37		UNION ¾	
38		UNION ½	
39	1	STRAINER 2"	BOMBARDIER CONTRACTOR
40	1	THERMOMETER 1½	
41	1	THERMOMETER 1	
42	2	THERMOMETER ¾	
43	4	THERMOMETER ½	
44	3	THERMOMETER ¾	
45	1	ORIFICE FLANGE 300 LBS 1½	

NOTES:
1) CONTRACTOR IS RESPONSIBLE TO PROVIDE NECESSARY UNION FOR DISASSEMBLING PIPING AND EQUIPMENT.
2) RADIATOR & HEATER TO BE PIPED AS APPROXIMATE
3) PIPING CONTRACTOR SHALL INSURE THAT ALL PIPE FOR PRESSURE AND TEMPERATURE GAUGES ARE THE SAME SIZE (SEE ELEVATION SEE DETAIL ON THE DWG.
4) CONTRACTOR IS RESPONSIBLE FOR REQUIRED PIPE RUNS TO ANY CONSTRUCTION IS REQUIRED WITH CONSULTATION WITH THE ENGINEER.
5) GENERAL INFO. APPLICABLE TO ALL PIPING WITH EXCEPTIONS
PIPE MATL :- A 53 SCH 40 CARBON STEEL
FITTINGS :- MALLEABLE IRON
2" PIPE :- A-53, BUNTING WELDED, 150# CLASS 14
6 ALL COMPONENTS WILL BE INSTALLED WITH NECESSARY FIELD ADJUSTMENTS BY THE CONTRACTOR TO SUIT.

No.	Date	Description	Init.
0	-	FOR QUOTATION ONLY	LH
1	03/12/13	ADD PIPING LINE	BS
2	03/12/13	ISSUED FOR CONFIRMATION	BS

Bombardier Inc.
Division des produits Terrestres et Grand Rail and Diesel Products Division
Montreal Quebec Canada

COOLING WATER & SUCKER WATER
FIRST CELL N° 6
AO-8827

FIG. XIV